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FIRST ANNUAL REPORT

OF THE

VISITORS OF THE

SHEFFIELD SCIENTIFIC SCHOOL,

TO THE

General Assembly of the State of Connecticut,

TOGETHER WITH AN HISTORICAL STATEMENT RESPECTING THE SCHOOL AND AN ACCOUNT OF THE ESTABLISHED COURSES OF STUDY.

NEW HAVEN:
PRINTED BY E. HAYES, 426 CHAPEL ST.
1866.

REPORT OF THE BOARD OF VISITORS.

To the General Assembly of the State of Connecticut:

THE undersigned respectfully report that they have discharged the duties devolving upon them as the Board of Visitors of the Sheffield Scientific School, two meetings having been held within the year for the appointment of state students, and one for the purpose of seeing the practical working of the institution in the middle of an academic term.

The Board are satisfied that the affairs of the school are conducted in a wise and efficient manner; that the funds derived from the Congressional grant are directed solely and economically to the promotion of the objects named in the Statute; that the instruction is comprehensive, liberal, and adapted to train up thorough scholars in the various branches of science, theoretical and practical, which are pursued in the school. These studies include, as will be seen, Agriculture and the Mechanic Arts, Chemistry, Mining, Metallurgy, Engineering, Military Science, Natural History and Geology, the Modern Languages, and other branches essential to a good education.

It is believed that Connecticut has been the first among the States of the Union to bring into actual operation the provisions of the act of Congress in reference to scientific education, and it is gratifying to the visitors to learn that the experience of the instructors in the Sheffield School has been carefully inquired into by the conductors of similar establishments in several other States.

In the place of a detailed report, the Board respectfully refer the Legislature to the accompanying document, prepared as a report to the Visitors by the officers of the School. This paper will be found to contain a historical sketch of the establishment, endowment, and enlargement of the institution, and a full statement of the various *courses of study in applied* and theoretical science now

in progress in its different departments, together with a list of the officers and students. The Board would particularly call the attention of the Legislature, and of the citizens of Connecticut, to the munificence of Joseph E. Sheffield, Esq., of New Haven, who, in addition to several former gifts amounting to over one hundred thousand dollars, has made during the past year a large addition to the edifice belonging to the school, besides important improvements and alterations in the former structure. This enlargement includes a three-story building connecting the two wings before erected, and a large tower designed for an astronomical observatory. A second tower, likewise for astronomical purposes, is about to be erected at the expense of the same gentleman, and he proposes in addition to give to the institution a telescope and meridian circle, together with a belfry clock. These improvements have been made by an outlay on his part of more than forty thousand dollars. Such increased generosity toward an institution in which the whole State is interested may assure the Legislature of the wisdom of directing to this establishment the national grant.

Special attention is also called to the fact that, in addition to the appointed courses of study, a series of evening lectures to mechanics has been given by the Professors in the School, and attended by about two hundred persons, nearly all of them engaged in industrial pursuits. The shorter course of instruction in Agriculture is designed in a fuller manner to meet the wants of young farmers.

It is desirable that the teachers of the State, and young men interested in scientific pursuits, should bear in mind that forty free scholarships in this institution are open to students from the State. Information regarding the mode of appointment may be obtained on application to any officer of the school.

In conclusion, we commend the Sheffield Scientific School to the confidence and support of the Legislature, and of enlightened friends of education in every portion of the State.

WILLIAM A. BUCKINGHAM,
ROGER AVERILL,
EDWARD I. SANFORD,
ORLANDO T. HODGE,
CHARLES A. ATKINS,
Board of Visitors.

New Haven, March 27th, 1866.

HISTORICAL STATEMENT AND PROGRAMME

Presented to the State Board of Visitors

BY THE

GOVERNING BOARD OF THE SCHOOL.

HISTORICAL SKETCH.

A YEAR having passed since the SHEFFIELD SCIENTIFIC SCHOOL began to enjoy the benefit of the national grant for the promotion of scientific education, it has become necessary, in accordance with the Act of Congress which conferred the grant, to publish a Report setting forth the operations of the School. Twenty years have also passed since the Corporation of Yale College inaugurated this scientific department of the University. The instructors accordingly regard this occasion as a fit time to place on record, in a connected form accessible to the public, a brief History of the School, together with a programme of the courses of study now established, and a fuller exhibition than has heretofore been made of the objects at which the institution aims. They hope to promote in this way a better acquaintance with the advantages and deficiencies of the present establishment, commemorate the services and benefactions of several friends of learning, and secure for the future the confidence and support of all who are interested in scientific studies.

In the history of the school, there have been three marked epochs;—first, its establishment by Yale College; second, its endowment by the great benefactor whose name it bears; and third, its enlargement by the grant of national lands, appropriated to the school by the Legislature of Connecticut. It will be convenient to divide this narrative into three corresponding sections.

I. THE ESTABLISHMENT.

Arrangements were made for commencing the school in the autumn of the year 1846, though no scholars were received till the beginning of the academic year in Sept. 1847.

Previous to that time, for many years, Prof. BENJAMIN SILLIMAN, the father, had received as his special pupils young men who de-

sired more thorough and extended instruction in Natural Science than was afforded in the College course. The philosophical apparatus of the College, the admirable cabinet of minerals, the scientific books in the library, and, more than all, the reputation of Professor Silliman, attracted to New Haven a large number of scholars thus devoted to natural science. Many such were never enrolled as students of any department of the College, but were regarded only as private pupils. Among them may be mentioned the names of Edward Hitchcock, Charles U. Shepard, T. Sterry Hunt, and John P. Norton. In 1842, Mr. Benjamin Silliman, Jr., made more formal arrangements for receiving as his private scholars in practical chemistry those who wished to pursue this study. A little later, in the spring of 1846, one of the pupils just referred to, who had been pursuing abroad a course of study in Agricultural Chemistry, returned to New Haven, well qualified to give instruction in that department of science. A friend of the College proposed to contribute $5000 toward a fund for a Professorship of Agricultural Chemistry; and, in the hope that a full endowment for such a chair would be speedily secured, Mr. JOHN P. NORTON was appointed Professor. The College authorities had long desired to make arrangements for teaching resident graduates and others in departments of study not included in the law, theological, medical, and academic departments, and were therefore readily led, at the Commencement in 1847, to the establishment of a fifth faculty, denominated the "Department of Philosophy and the Arts." To this Mr. Norton was assigned. Mr. BENJAMIN SILLIMAN, Jr., was also appointed Professor of Chemistry in its Application to the Arts, and these two gentlemen at once became associated in the opening of an analytical laboratory, which was the nucleus of the present Scientific School. The dwelling house which for two generations had been occupied as the President's residence was vacated in 1846, on the resignation of President DAY, and was assigned to the uses of this new school. There were no funds for the payment of instructors or the purchase of apparatus, and most men would have shrunk from the beginning of an enterprise which promised so little reward. But these two chemists were enthusiastic in their chosen pursuits, and they persevered in spite of all the difficulties which they encountered. Their work, however, was soon interrupted

by Prof. Silliman's appointment to a professorship in the Medical School at Louisville, Ky., and by the death of Prof. Norton.

To the memory of the latter, as one of the originators of the School, a tribute of respect is here most justly due. A man of fine endowments and of bright promise, whose opportunities were most favorable for pursuing any career which might seem to him attractive, he determined to enter on the life of a farmer. In later years, as education developed his intellectual character, he resolved to devote himself in an especial manner to the improvement of American agriculture, and to qualify himself to teach and lecture in those departments of science which are most nearly related to the farmer's pursuits. Having improved the best advantages which this country afforded, he continued his preparatory studies in Edinburgh and Utrecht, and returned to this country well fitted for his work. His natural powers, his early advantages, his enthusiastic and industrious acquisition of knowledge, and his aptness to teach, gave promise of a life of great usefulness, and his appointment to the newly established chair of Agriculture in Yale College was everywhere rejoiced in. During the five years of life which remained to him he became widely influential in the promotion of superior methods of agriculture, using freely his pen, voice, purse, time, and influence to accomplish the work to which he was devoted.

Eleven scholars became members of the School during its first year, six of them having previously received a college education. The building just referred to was fitted up as a chemical laboratory, and the pupils began with enthusiasm their studies. Prof. Norton lived to see the number of scholars trebled, and a class of eight young men, three of whom are now Professors in the School, complete a course of scientific study. Six of these scholars received in 1852 the degree of Ph.B., and were the earliest graduates of the Scientific School.

The death of Mr. Norton, in 1852, severely affected the prospects of the School. But circumstances favored its continuance, and the Catalogue of the College for 1852–3 announced that Professor JOHN A. PORTER, had consented, at the request of the College, to take charge of the Laboratory. This temporary engagement resulted in his prolonged identification with the interests of the School. Sixteen Chemical students were then enrolled on the Catalogue. In the same year (1852), Professor

WILLIAM A. NORTON, a graduate of the U. S. Military Academy at West Point, was appointed to be Professor of Civil Engineering in Yale College, and he proceeded to organize what is is now the Engineering Section of the Scientific School, and was then denominated the School of Engineering. The fourth story of the present Chapel, formerly used as the College Library, was assigned to his classes, and a plan of study extending through two years was arranged. As in the School of Applied Chemistry, the instructors were remunerated only by the fees which were paid by the scholars. Prof. Norton began his instruction in Engineering with twenty-six students. In 1854, the classes in Chemistry and Civil Engineering were associated under the name of the Yale Scientific School. In 1855, Prof. JAS. D. DANA, who had already been appointed a Professor in the Academical department, was also announced as one of the instructors in the Scientific department, and important plans were at once matured for a thorough re-organization of the School and enlargement of its courses of study. The value of a special course of instruction in Mining and Metallurgy, with especial reference to developing the mineral resources of the country, was then recognized by the appointment of Mr. GEO. J. BRUSH, one of the earliest pupils of the school, to be Professor of Metallurgy; and Mr. S. W. JOHNSON, another pupil of the school, was added to the corps of instructors, first as the Senior Assistant in Chemistry, and the next year as a full Professor. Mr. L. BAIL was attached to the Engineering Department as Instructor in Drawing.

II. THE ENDOWMENT.

The experience of ten years had now demonstrated the importance of this Department of Yale College. The growing demand for scientific instruction, the observation of European schools of science, and the rapid development of the material resources of the country, indicated the need of a well organized school, in which still other departments of instruction should be introduced, and a more thorough and systematic plan of training should be developed. But nothing could be done without funds, and the school had remained till this time almost without endowment.

It is true that Mr. JOHN T. NORTON, of Farmington, had made an annual contribution of three hundred dollars; that the venerable President DAY had shown his enlightened interest in the department by requesting the Corporation to devote to the school his subscription of one thousand dollars; and that Mr. Jos. E. SHEFFIELD had made his first contribution, amounting to five thousand dollars.

But all this help, encouraging as it was, was quite inadequate to the efficient maintenance of the school, and accordingly new measures were proposed for enlisting the sympathy of the friends of the enterprise. Various pamphlets were prepared and published, setting forth the wants of the school as a whole, and also of particular sections. Repeated conferences were held of those who desired the firm establishment of the institution, and by means of the public journals and newspapers much was done to diffuse a knowledge of what foreign countries offered in the way of scientific training, and of what was possible in Connecticut. Many of the most active members of the Connecticut Agricultural Society contributed to the encouragement of these plans. An address by Prof. Dana, given before the citizens of New Haven, and repeated before the Graduates of the College at Commencement, increased this interest. Several new subscriptions were made. Mr. SHEFFIELD added to his former gift five thousand dollars; Mr. O. F. WINCHESTER subscribed five thousand dollars; Mr. ELI WHITNEY also offered one thousand dollars; Mr. DANA gave five hundred dollars; and Miss HILLHOUSE gave to the school her interest in a large landed property at the South.

Subsequently subscriptions of one thousand dollars each were received from Mr. A. R. STREET, Mr. P. PERIT, and Mr. Jos. BATTELL, besides others of less amount from other liberal gentlemen.

Thus matters went on till Mr. Sheffield, whose generosity had already repeatedly brought encouragement to the desponding friends of the school, came forward and proposed to provide a building and a permanent fund. Having purchased of the Medical Institution the edifice at the head of College street in Grove street, he refitted it throughout, added two large wings, provided for the school a large amount of apparatus, and gave a fund of $50,000 for the maintenance of Professorships of Engineering, Metallurgy, and Chemistry. This enlightened benefaction, the

largest which the College had received from any source, was completed in 1860, and secured the permanence of the school. In recognition of his bounty, which amounted to over $100,000, the Corporation of Yale College gave his name to the establishment.

It should here be mentioned that, in anticipation of the completion of the edifice, a course of lectures on agricultural subjects was offered to the public under the auspices of the school and the special direction of Prof. John A. Porter. Though the building was not ready, the lectures were commenced on the first of February 1860, and continued nearly four weeks. Twenty-six gentlemen from various parts of the country, distinguished in different specialties, participated in the instruction, and it is estimated that not less than five hundred persons were attracted to New Haven during the continuance of the course. Three or four lectures were given daily, and discussions were interspersed, reports of them all being widely disseminated in the newspapers of the day, and afterwards in a volume by Mr. Henry S. Olcott. Much of the later interest through the country on agricultural education has been attributed to this convention.

The transfer to the new building was made in the summer of 1860. A third course was added to those already established, under the title of the General Course, designed to extend through three years, and to furnish good instruction in the elements of various departments of Natural Science and in Modern Languages. The corps of instructors was also enlarged by the appointment of Rev. C. S. Lyman to a professorship of Industrial Mechanics and Physics, and by inviting Prof. W. D. Whitney, who was already connected with the College, to give instruction in the Modern Languages. The work of the school in each section was then definitely marked out for each year, regular Faculty meetings were commenced, a formal examination was required of every candidate for admission, and the second degree of Ph.D. was instituted by the Corporation as an incentive to a protracted course of study and advanced attainments in the higher branches of science.

Further changes and enlargements have since been effected, but now for the first time the whole school was organized as one compact institution.

III. The Enlargement.

The demand for scientific education which was felt throughout the country led Congress, in 1863, in compliance with petitions from various parts of the nation, including one from the instructors of this School, to pass a bill appropriating to every State a portion of the public lands, for the purpose of encouraging instruction in theoretical and applied science. Connecticut received from this source the scrip or warrants for one hundred and eighty thousand acres of land. It was a condition of the gift that the lands should be sold and the proceeds invested so that no part of the principal should be expended. It was also required that no part of the income should be paid out for buildings. A large additional sum was therefore necessary to render the appropriation available to the State. Moreover, the amount which it was thought would be derived from sale of lands, though considerable, was wholly inadequate to the annual cost of maintaining such a school as the act of Congress contemplated. It was not surprising, therefore, that the Sheffield Scientific School was the only institution in the State which volunteered to avail itself of the provisions of the grant. Here an admirable building was already in use, and other funds had been gathered amounting in all to about $75,000—held in trust for the specific objects contemplated in the national grant. These facts were presented to the Legislature. The Judiciary Committee, consisting of some of the ablest men in the General Assembly, were requested to investigate the whole question. They came from Hartford to visit the school, and recommended that the appropriation be made in accordance with the application of New Haven. A bill was drafted, which passed the House with but one dissenting voice and the Senate unanimously, and became a law.

The Governor, the Lieutenant Governor, the three senior Senators, and the Secretary of the State Board of Education were constituted Visitors on the part of the State.

The lands were subsequently sold, and a contract was signed between the State and the College, providing that the income of the fund should at once and forever be directed to the enlargement and improvement of this institution. By the terms of the public grant, arrangements were made by which a certain number of young men may be admitted gratuitously to the privileges of

the institution. Forty free scholarships are thus open to deserving students from the State of Connecticut. Announcements are annually published in the newspapers of the state, calling the attention of the public to the advantages here proffered.

The authorities of the School, recognizing the intent of Congress to promote instruction in Agriculture and Mechanics, regarded these departments as among the first to receive attention. Prof. Lyman was thus enabled to organize and announce a special course of instruction in Mechanics in the Engineering Section, and Prof. W. H. BREWER, then engaged in the Geological Survey of California, a graduate of the School, well known as a practical and scientific agriculturalist, was invited to a professorship of Agriculture. He returned to New Haven in 1864, and has organized this section of the School. His chair was named the Norton Professorship, in honor of the early benefactors of the school.

The faculty of the School was further enlarged by the appointment, in 1863, of Mr. D. C. GILMAN to be Professor of Physical Geography, and, in 1864, of Mr. D. C. EATON to be Professor of Botany and Mr. A. E. VERRILL to be Professor of Zoology.

Measures have recently been taken to organize a Mining Section of the school, in accordance with the plan which was formed when Mr. BRUSH first joined the Faculty, and Mr. A. P. ROCKWELL was appointed in 1865 to be the Professor of Mining.

In 1864, Professor JOHN A. PORTER felt compelled by the failure of his health to resign the professorship which he had filled for eleven years previous. During much of that time the funds of the school were so restricted that he received but a nominal remuneration for his services; but he was always untiring in his efforts for the advancement of this department of the College, and it is especially to be remembered that when the prospects of the school were far from hopeful, his zeal and his confidence in ultimate success continued unabated. The course of Agricultural Lectures, already spoken of, the consolidation of the various departments of instruction into a well organized school, the establishment of the Select Course of study, and the wide diffusion of information respecting the advantages and necessities of this growing institution, are among the important measures with which his name will always be associated.

In the summer of 1865, Mr. Sheffield, perceiving that the building was already inadequate to the wants of the school, proceeded to make an important enlargement to the edifice, connecting by means of a three-story structure the wings before built. In this way an addition to the Laboratory, a commodious lecture-room for the Agricultural department, and an attractive library-room were secured. Other important improvements were also made, at his expense, in the original structure. He also caused a tower to be erected in the front of the building, on which he proposes to place astronomical instruments and a belfry clock. These generous gifts can not fail to be regarded by the State as evidence that the public grant was wisely bestowed.

In the winter and spring of 1866, a course of lectures to Mechanics was given by the Professors of the school. They were attended by about two hundred persons, most of them engaged in the practical occupations of life. The following programme specifies the lecturers and their subjects:

EVENING LECTURES TO MECHANICS, 1866.

1. Jan. 29, Introductory, on Science and the useful arts,—Prof. LYMAN.
2. Feb. 5, On Air,—Prof. SILLIMAN.
3. " 8, " Water, " "
4. " 12, " Carbon, " "
5. " 15, " The Mountain Scenery of California,—Prof. BREWER.
6. " 19, " The Cultivation of Taste as applied to the Ornamental Arts or Curvilinear Design,—Prof. BAIL.
7. " 22, " Dry-rot, Smut, and Mildew,—Prof. BREWER.
8. " 26, " Mechanical Drawing,—Prof. BAIL.
9. Mar. 1, " The History of the Art of Writing,—Prof. WHITNEY.
10. " 5, " The Principles of Chemistry,—Prof. JOHNSON.
11. " 8, " " " "
12. " 12, " Iron and Steel,—Prof. BRUSH.
13. " 15, " " " " "
14. " 19, " Silk Worms,—Prof. VERRILL.
15. " 22, " Insects Destructive to Wood and Timber,—Prof. VERRILL.
16. " 26, " Combustion and Fuel,—Prof. SILLIMAN.
17. " 29, " Perpetual Motion,—Prof. LYMAN.
18. Apr. 2, " The Cultivation of the Grape,—Prof. BREWER.

For a more particular account of the building and for a minute statement of the courses of study now in operation, reference is made to the following programme.

The number of pupils connected with the school is at present ninety-two, thirty-one of them being from Connecticut.

COURSES OF INSTRUCTION.

Building, Apparatus and Library.

By the liberality of Joseph E. Sheffield, Esq., of New Haven, an admirable building, known as "Sheffield Hall", has been provided for the uses of the school. It has recently been enlarged and remodelled, and is believed to be the most complete of its kind in the country. It contains recitation and lecture rooms for all the departments of the school, a hall for public assemblies and lectures, a drawing room for the engineering class, laboratories for chemical and metallurgical investigations, a photographical room, an astronomical observatory, a museum, a library and reading room, besides studies for some of the professors, where their private technical libraries and collections are kept.

The school is also supplied with excellent instruments and apparatus, and with valuable collections illustrative of the studies pursued in the school. For a more particular account of these advantages reference may be made to the separate statements which follow.

The university museum, which is rich in the departments of geology and mineralogy, and is rapidly increasing in the department of zoölogy, is open to the students.

There is a small working library of technical books belonging to the school, to which additions will soon be made. The college library, numbering about 45,000 volumes, and the society libraries, numbering 26,000 volumes additional, can be used by all who desire to do so.

Degrees.

The degrees below named are conferred by the Corporation of Yale College on students who have passed the required examinations at the close of their course, and are recommended as candidates by the governing board of the school.

1. Bachelor of Philosophy, conferred at the termination of three years' study in any one of the several sections of the school.

2. Doctor of Philosophy, conferred on those who have already been admitted to the degree of Bachelor in Philosophy, Science, or Arts (in this or any other college), and who *have* successfully pursued in this

college a higher course of study. When the Baccalaureate degree does not indicate an acquaintance with the Latin and Greek languages, the candidate will be required to show some proficiency in these studies.

3. Civil Engineer, conferred on students of the engineering section who have already taken the degree of Ph.B., and subsequently pursue with success the higher course of engineering.

In addition to the diploma of the Corporation, the instructors will give a formal certificate stating how long the student has been a member of the institution and in what department of study he is proficient. This certificate will be awarded only to meritorious students, after a thorough examination, and will be considered as the personal recommendation of the professors who sign it.

Terms of Admission.

The pupils of the scientific school are of three sorts: first, those who are pursuing a systematic and prescribed course of study, extending through three years, and leading to the degree of Bachelor of Philosophy; second, those who having already been admitted to the degree of Bachelor of Philosophy, Science, or Arts, are pursuing an advanced course of study leading to the degree of Doctor of Philosophy, or in some cases to the degree of Civil Engineer; and third, special students, who have already made a considerable degree of proficiency in some department of science, and are now pursuing certain special studies under the personal direction of some of the professors.

All applicants for admission must be not less than sixteen years of age, and must bring satisfactory testimonials of good character. Students intending to enter on the higher and special courses of study must exhibit satisfactory evidence of their fitness to take up the branches they propose to pursue.

Students desiring to go through any one of the regular courses of the school as candidates for the degree of Bachelor of Philosophy must sustain an examination in the following books, or their equivalents.

Arithmetic—Thomson's Higher Arithmetic. *Algebra*—Day or Davies. *Geometry*—Davies's Legendre. *Plane Trigonometry*—Loomis or Davies. *The Elements of Natural Philosophy*—Loomis or Olmsted. *English Grammar, Geography, and the History of the United States.*

An acquaintance with the Latin language is recommended to the student, as facilitating the study of the sciences and of the modern

languages pursued in the school; and although this is not yet required as a condition of admission, it will probably be so at an early day.

In consequence of the incomplete preparation of many of the candidates, it is proper to say that the examination for admission is strict and full. As the studies just named are not pursued in the school, and are essential to successful progress, no one can be received as a scholar who is not well acquainted with these branches.

Candidates for advanced standing are examined, in addition to the preparatory studies, in those already pursued by the class they propose to enter. Any person admitted to an advanced standing, unless coming from another college, pays the sum of ten dollars as tuition money for each term which has been completed by the class which he enters. No one can be admitted as a candidate for a degree after the commencement of the last year of the course.

The regular examinations for admission to the Scientific School take place at Sheffield Hall on the Tuesday preceding "Commencement" (the last Thursday in July), at 9 o'clock, A. M., and seven weeks later, on that Wednesday in September on which the fall term begins. Opportunity for private examination may, in exceptional cases, be given at other times.

Courses of Lectures.

The instruction of the school is given chiefly by recitations and by inciting the student to engage in the thorough investigation of such topics as are brought before him. At the same time, for awakening the interest of the scholars in their various studies, for bringing out the latest results of scientific inquiry, and for introducing practical and experimental illustrations, several courses of lectures are given annually. The following are the most important:

By Prof. NORTON. A course on the Strength of Materials.

By Prof. LYMAN. 1. A course on the Principles of Mechanism. 2. A course on the Steam Engine.

By Prof. WHITNEY. A course on the History of Language and Linguistic Ethnology, in the fall and winter terms.

By Prof. BRUSH. 1. A course on Metallurgy, in the fall and winter terms. 2. A course in Mineralogy, in the summer term.

By Prof. GILMAN. A course on Physical Geography, in the winter term.

By Prof. JOHNSON. A course on Agricultural Chemistry and Physiology, extending through the fall and winter terms.

By Prof. BREWER. 1. A course on Practical Agriculture, in the fall and winter terms. 2. A course on Rural Economy and Farm Management, in the summer term.

By Prof. ROCKWELL. A course on Mining, in the fall and winter terms.

By Prof. EATON. A course on Botany.

By Prof. VERRILL. 1. A course on Structural and Systematic Zoology, during the winter and summer terms. 2. A course on Entomology and other special subjects, in the autumn term.

During the past year a course of lectures on Military Science and Tactics has been given by Gen. A. Von Steinwehr, U. S. V.

By the courtesy of the instructors in the Academical Department, some of the classes in the school are permitted to attend the lectures given on History and Political Philosophy by President WOOLSEY, on Philosophy by Prof. PORTER, on Physics and Meteorology by Prof. LOOMIS, on Geology by Prof. DANA, on Chemistry by Prof. SILLIMAN, and on Anatomy and Physiology by Dr. SANFORD.

Courses of Study for the Candidates for the Degree of Bachelor of Philosophy.

These courses of instruction occupy a period of three years. During the first, or Freshman year, all the students pursue the same studies. At its close they are required to select one of several prescribed courses, and they are not allowed to change from one course to another except by special permission. Examinations are held at the end of every term on the studies of the term, and at the close of every year on the studies of the year.

The following separate courses of study are now provided for the Junior and Senior years:

1. Chemistry and Natural Science.
2. Civil Engineering.
3. Mechanics.
4. Mining and Metallurgy.
5. Agriculture.
6. Natural History and Geology.
7. Select Course in Literature and Science.

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Freshman Year.

INTRODUCTORY TO ALL THE SECTIONS OF THE SCHOOL.

FIRST TERM.

Mathematics—Davies's Analytical Geometry. Spherical Trigonometry. Surveying. *Physics*—Silliman's Principles. *English Language*—Exercises in Composition. *Chemistry*—Wells. *German*—Woodbury's Method and Reader.

SECOND TERM.

English—Rhetoric. Practical Exercises in Elocution. *German*—Woodbury continued. Selections from approved authors. *Physics*—Silliman's Principles, and Academical Lectures. *Chemistry*—Wells. *Mathematics*—Descriptive Geometry and Geometrical Drawing. *Botany*—Gray's First Lessons.

THIRD TERM.

English—Exercises in Composition. *German*—Selections. *Physics*—Silliman's Principles, and Academical Lectures. *Chemistry*. *Mathematics*—Principles of Perspective. *Botany*—Gray's Manual. *Drawing*—Free Hand practice.

I. COURSE IN CHEMISTRY.

The Sheffield Laboratory is conducted by the Professor of Agricultural and Analytical Chemistry, the Professor of Mineralogy and Metallurgy, and their assistants. It is fitted up in a very complete and convenient manner, is provided with all the requisite apparatus and instruments of research, possesses a considerable collection of chemical preparations, and a consulting Library of the best treatises on Chemistry and the Chemical arts. It affords facilities for instruction in the various branches of theoretical and practical Chemistry.

Theoretical and Descriptive Chemistry are taught throughout the whole of the Junior year by recitation, Miller's Elements being employed as a text book. The Lectures of Professor Silliman to the Academical and Medical Classes are also accessible to the students. Every autumn term a class recites from Fresenius' Qualitative Analysis. Extended courses of Lectures on Agricultural and Metallurgical Chemistry, and Mineralogy, are given yearly.

The Laboratory is open for Chemical Practice seven hours daily, except on Saturday, when it is closed in the afternoon. The student works through a course of qualitative and quantitative analysis, which is varied according to his capacity and the object he has in view. Each pupil proceeds by himself independently of the others, under the constant guidance of the Instructors.

In connexion with the department of Mining and Metallurgy, especial attention is given to assaying and the investigation of ores and furnace products and the discrimination of minerals. The student in Agriculture has opportunity to acquaint himself with the modes of research employed in agricultural chemistry. The applications of the science to other branches of industry are taught as occasion requires.

The systematic course includes instruction in Zoology, Botany, Geology, and the French and German languages, as will be seen from the following programme:

Freshman Year, (see page 21.)

Junior Year.

General Chemistry—Miller's Elements, Recitations. *Mineralogy*—Dana's System, Lectures and Practical Exercises. *Botany*—Gray's Manual, Excursions and Preparation of Herbarium. *Zoology*—Lectures and Excursions. *French and German*—(See Select Course). *Analytical and Experimental Chemistry*—Fresenius. Recitations and Lectures. *Laboratory Practice*—Systematic Qualitative Analysis. Use of the Blowpipe. Toxical Examinations. Elements of Quantitative Analysis.

Third or Senior Year.

General and Experimental Chemistry—Academical and Medical Lectures. *Agricultural Chemistry and Physiology*—Lectures. *Metallurgy*—Lectures. *Geology*—Dana's Manual. Recitations and Academical Lectures. *Human Anatomy and Physiology*—Academical Lectures. *Mechanics, Steam Engine and other Prime Motors*—Lectures. *French or German*—(See Select Course). *Laboratory Practice.* Quantitative Mineral Analysis. Assaying. Organic Analysis. Special Investigations for Graduating Thesis.

To advanced students, whether belonging to the regular classes or not, who desire to give attention to particular branches of chemistry, or to pursue original investigations, every facility is accorded.

The private libraries of the professors, containing the chemical journals and the recent foreign literature of chemistry, the large collections of ores, furnace products, &c., belonging to the department of Metallurgy, and the private cabinet of the professor of Mineralogy, are freely used as aids in instruction.

II AND III. COURSES IN ENGINEERING AND MECHANICS.

The section of *Engineering and Mechanics* embraces the two divisions of *Civil Engineering* and *Industrial Mechanics*, or Mechanical Engineering. In each division, the special instruction occupies two years; and is preceded, as in the other departments, by a preparatory course of one year. These professional courses comprise both theoretical studies and practical exercises in field operations and in drawing. They are designed, at the same time, to furnish the requisite knowledge of the theory and practice, and to give a good degree of facility in the use of instruments, in the field and in all graphical processes.

The course of *Civil Engineering*, including the mathematical studies of the first, or preparatory year, comprises the following general departments of study.

(1.) *The Higher Mathematics*, consisting of the following special studies and exercises: Spherical Trigonometry; Analytical Geometry, of lines, and the different classes of surfaces: the Differential and Integral Calculus, with applications to the solution of geometrical and mechanical problems; Descriptive Geometry, and coördinate branches of study—embracing the mathematical theory of Geometrical Drawing in its various branches, and the solution of graphical problems of three dimensions, illustrated by geometrical models; Surveying under the several heads of Compass and Chain Surveying, Theodolite Surveying, Levelling, Survey of Harbors and Rivers, Topographical Surveying, and Geodesy.

The course of field operations includes the adjustment of surveying instruments, and is sufficiently extensive to secure facility in the use of all the instruments, as well as a practical knowledge of the different branches of Surveying. It is accompanied by practical exercises in the use of scales and protractors; and in the making of plots, charts, and topographical drawings, from the results of the survey of fields, harbor, inequalities of surface of ground, &c.

(2.) *An extended course of Drawing*, comprising the drawing of Plans and Elevations; Shading and Tinting; Linear Perspective; Free Hand Drawing; Sketching from models and from nature; Isometrical, Topographical, Mechanical, Architectural, and Structural Drawing. The exercises in drawing are illustrated by models—topographical, architectural, &c.

(3.) *Theoretical Mechanics;* and *Mechanics applied to Engineering.* The Applied Mechanics includes the dimensions and stability of Retaining Walls; the complete theory of Arches, with detailed calculations of proportions required for stability; the theory of Framings of wood and iron; Work done by animal agents, operating either directly, or by aid of machines; working condition and efficiency of Machines; measurement of power exerted, or work done, by means of Dynamometers; collection, leading, and utilization of Water as a prime-mover; construction and theory of the different forms of vertical Water Wheels, and of Turbines; supply of water in Conduit-pipes; Pumps; Hydraulic Engines; construction and theory of the Steam Engine, illustrated by sectional and working models, and drawings; Principles of Mechanism, &c.

(4.) *Field Engineering*, which embraces a course of exercises in laying out curves, running lines, traverses, &c., with the transit and chain; surveys with transit and level preparatory to the location of a road; establishing the grade, and making the requisite calculations of excavation and embankment; staking out the road, and setting the slope-stakes preparatory to construction.

(5.) *Civil Engineering* proper, or the *Science of Construction.*—The principal topics embraced under this general designation are, the properties of Building Materials, and their preparation for use; Strength and Stiffness of Building Materials, and of Framings; establishment of Foundations of Masonry; Construction of Masonry, in walls, arches, and bridges; Framing of roof-trusses, centres, and bridge-trusses, in wood and iron; detail of the construction of Bridges, Roads, Railways, and Canals; Equipment and Operation of Railroads; Navigation of Canals; mathematical and mechanical principles of Bridge Construction, with detailed calculations of the proportions of parts, requisite for stability; Stone Cutting, with graphical problems furnished by models of arches, staircases, &c. The laws of the strength and stiffness of beams and trusses are theoretically investigated, and the calculated strains and deflections are experimentally tested, by means of an apparatus contrived for the purpose.

(6.) *Astronomy*, by text-book instruction and lectures; Astronomical Problems.

(7.) *Physics*, by text-book and lectures.

(8.) Lectures on Geology, and on the Chemistry of Building Materials.

(9.) The French and German Languages.

The student in the department of Engineering who, on the comple-

tion of this course, has taken the degree of Bachelor of Philosophy, has the opportunity of pursuing a *Higher Course*, designed to give a special training, preparatory to professional practice. This includes, together with higher theoretical studies, Practical Astronomy, with exercises in astronomical observations with the Transit Instrument, Meridian Circle, Zenith Telescope, and Sextant; and a course of exercises in the designing of structures. At the completion of this higher course the degree of Civil Engineer is conferred upon examination, and upon sufficient evidence being given of the ability of the student to design important structures, and make the requisite drawings, calculations and estimates.

The department is provided with a set of instruments for Surveying and Field Engineering; a large collection of models of geometrical surfaces, including warped surfaces, and in illustration of the intersection of surfaces; models in illustration of problems in Descriptive geometry; a set of models of arches of various forms; a large collection of topographical models; also various constructional and architectural models, including models of the different orders of architecture, &c.; also a suit of apparatus for experimenting on the strength and stiffness of beams and trusses.

The astronomical instruments are, a forty-inch Meridian Circle, with five-foot telescope and four reading microscopes; an Equatorial Telescope of nine inches aperture and eleven feet focal length, with clock-motion, etc., by the celebrated makers Alvan Clark & Sons; a five-foot Telescope of four and two-thirds inches aperture, the object-glass by the same makers; a three-foot Transit Instrument, adapted to be used also as a Zenith Telescope; and a Pistor & Martins' Patent Sextant;—a collection affording rare facilities for training students in Practical Astronomy.

The *Course of Industrial Mechanics and Mechanical Engineering* is identical with that of Civil Engineering in the several studies enumerated above under the first, second, third, seventh, and ninth heads, with the exception of the higher Surveying and Topographical Drawing. It embraces, in addition, Analytical Mechanics, fuller instruction in Mechanical Drawing and in the Theory and Construction of Machines, Mill work, visits to machine shops and manufactories, with reports of Machines and Engines, Designs of Machines, and practice in use of tools and in the construction of Machinery.

There is no shop connected with the School, but, for those who wish it, practice can be had, to whatever extent may be desirable, in some of the extensive machine *shops of the city.*

The Mechanical Cabinet, but just commenced, includes, among other apparatus, several valuable models of steam engines, presented by their owners or builders. It is intended to embrace ultimately a full collection of such machines and models as shall best illustrate mechanical principles, and exhibit the present state of the mechanic arts. Inventors and machinists will confer a favor on students in mechanism by depositing here models and drawings of machines or parts of machines.

IV. COURSE IN MINING AND METALLURGY.

Although this section of the school has been but recently organized, instruction preparatory to mining and metallurgical pursuits has been given in the school since 1857. The Freshman year is the same as in the other courses. See page 21. The Junior year is devoted to special subjects included under Engineering and Mechanics, to Geology, Mineralogy, and the French and German languages. The Senior year is occupied with Mining and Metallurgy, and laboratory practice in Chemical Analysis, including Assaying, the determination of the character and value of ores and furnace products, and the discrimination of minerals. Drawing is continued through both years. The lectures on Mining will discuss in detail known facts in regard to *Ore Deposits—strata, beds, veins or lodes, stockworks and other irregular masses; Dislocations—faults, and other irregularities; Methods of search; Boring of different kinds with the various apparatus; Tools used in various kinds of mining and in different countries; Blasting; Sinking of shafts; Driving of Levels and Galleries; Timbering, Masonry and Tubbing for securing underground openings; Exploitation, or the opening out of mines and the working away of veins and strata; Transportation underground; Winding or raising the minerals to the surface, and machinery and apparatus; Pumps and Pumping Engines; Ventilation, its principles and practice, natural and artificial, by furnace and machines; Lighting—safety lamps; Mechanical Preparation of Ores*, etc.

The lectures on Metallurgy will be divided into: (1.) *General Metallurgy*, including the physical and chemical properties of the metals and their ores, and of slags and other furnace products, the different methods used in both the dry and wet way in the extraction of metals; the character and effect of the different kinds of fuel; the materials employed in the construction of furnaces, crucibles, etc.; the details in regard to different forms of furnaces, blast, etc. Under (2.) *Special Metallurgy, each metal* will be considered by itself, its physical and

chemical characters given in detail, with the characteristics of its ores, the methods for their assay, and the metallurgical processes employed for the extraction of the metal or metallic compound.

The mining and metallurgical department is supplied with models and diagrams of machinery, furnaces, etc., and the metallurgical cabinet contains a large collection of specimens of vein-stones, and extensive suites of ores and furnace products, illustrative of the mines and smelting works of our own country and of Europe.

In extension of the present course it is proposed to add at least one year for a higher course, analogous to the higher course in Civil Engineering; this will include four to six months practice in the field in the study of mines and smelting works, to be followed by special Engineering or Chemical studies as applied to Mining and Metallurgy.

Freshman Year. (See page 21.)

Junior Year.

FIRST TERM.

French and German—(See Select Course.) *Mathematics*—Descriptive Geometry (Church's). Analytical Geometry of Three Dimensions. *Mechanics*—Peck's Elements. *Geology*—Dana. *Drawing.*

SECOND TERM.

French and German—(See Select Course.) *Mathematics*—Davies's Shades, Shadows, and Linear Perspective. *Mechanics*—Peck's Elements (continued). Principles of Mechanism. Theory of Steam Engines. *Civil Engineering*—Strength of Materials. Stability of Arches. Stone Cutting, with graphical problems. *Geology*—Dana (continued).

THIRD TERM.

French—(See Select Course.) *Mathematics*—Isometrical Projection. *Mechanics*—Mechanics applied to Engineering. *Surveying*—Higher and Topographical Surveying. *Drawing*—Topographical.

Senior Year.

FIRST TERM.

Mining—Lectures. *General Metallurgy*—Lectures. *General Chemistry*—Miller: Non-Metallic Elements. Recitations and Academical Lectures. *Chemical Analysis*—Fresenius. Recitations and Lectures. *Laboratory Practice*—Qualitative Analysis. *French*—(See Select Course.) *Drawing*—Architectural and Mechanical.

SECOND TERM.

Mining—Lectures. *Special Metallurgy*—Lectures. *General Chemistry*—Miller, Chemistry of Metals. Recitations and Lectures. *Laboratory Practice*—Qualitative Analysis (continued). Use of Blowpipe. Quantitative Analysis (commenced). Assaying. *Zoology*—Lectures. *French*—(See Select Course). *Drawing*—(continued).

THIRD TERM.

Mineralogy—Dana. Lectures and Practical Exercises. *Laboratory Practice*—Quantitative Analysis (continued). Assaying. *Drawing*—Designs of Structures.

V. COURSE IN AGRICULTURE.

The recent founding of the Norton Professorship of Agriculture, and of Professorships of Botany and Zoölogy, has led to the organization of a more extended and systematic course of Agricultural instruction.

This course is intended to prepare the student for the successful management of a farm by putting him in possession of a knowledge of the most approved methods of culture at present employed, and by explaining, so far as the state of learning admits, the reasons for these methods.

It is not expected to give a young man that familiarity with the mechanical operations of husbandry or that business capacity which are essential to the good farmer. These can only be acquired by assuming or sharing the care of a farm.

The course is in consequence adapted to those who are already familiar with rural affairs. Those who are practically ignorant of the varied details of farm practice can scarcely learn them thoroughly in an agricultural school, nor can they profit fully by the lessons proper to such an institution.

The main features of the course are, in addition to the mathematical and general studies of the first year, extended instruction by lecture in the Theory and Practice of Agriculture in all its branches; instruction in the French and German languages, in the accessory sciences, Chemistry, Botany, Zoölogy, Geology, Meteorology, and training in free-hand Drawing and experimental Chemistry.

PROGRAMME OF STUDIES.

Freshman Year. (See page 21.)

Junior Year.

Agricultural Chemistry and Physiology—Structure and Physiology of Plants; Water, Atmosphere, and Soil in their relations to Vegetable Production; Improvement of the Soil by Chemical and Mechanical means. Domestic Animals: the chemical relations of their Food, Digestion, Respiration, Assimilation, and Excretion; Milk, Butter, Cheese, Flesh, and Wool as Agricultural products. Lectures. *Experimental and Analytical Chemistry*—Laboratory practice. *Meteorology*—Academical Lectures. *Physical Geography*—Lectures. *Zoölogy*—Lectures. *Drawing*—Free-hand practice. *French and German*—continued. *Excursions*—Botanical, *Zoölogical, etc.*

Senior Year.

Agriculture—The staple crops of the United States, their varieties, cultivation, management, and preparation for market. The Care, Breeding and Raising of Domestic Animals. Lectures and Recitations. *Experimental Chemistry*—Laboratory practice. *Agricultural Zoology*—Natural History of Domestic Animals; Insects useful and injurious to Vegetation. Lectures. *Human Anatomy and Physiology*—Lectures. *Geology*—Lectures and Recitations. *Rural Economy*, both American and foreign. Lectures. *French and German*—continued. *Excursions*—Botanical, Zoölogical, etc.

Opportunities are offered for more special attention to Horticulture, Forestry, or to any of the sciences taught in the course, in their application to particular departments of Agriculture. Many important topics in Agricultural practice not mentioned in the above brief programme—for example, the selection and care of implements; farm buildings; fencing; plan of work for the year as adapted to the season, &c.; methods of conducting farm experiments, &c., &c.—will also be suitably discussed.

Excursions in the neighborhood, and occasionally to a distance, under direction of the Professors, will teach the modes of observing natural objects, especially plants and insects useful and injurious in Agriculture, and will furnish illustrations of live stock, of farm buildings, of orchards, market gardens, use of implements, &c.

A museum of soils, fertilizers, agricultural products, and useful and injurious insects, and numerous diagrams for illustration, are provided, and students have access to the collections in the various departments of science, with which the College is provided.

A shorter course is open to maturer persons who wish to devote a limited time to a selection of the more practical topics. For admission to this course no examination is required; but testimonials of good character and ability to profit by the instruction must be presented.

Shorter Course in Agriculture.

For this course the instruction is so arranged that the more important topics, viz: Practical Agriculture, Agricultural Chemistry and Physiology, Agricultural Zoölogy, Physical Geography, Forestry, &c., are discussed during the fall and winter terms of each year (September to April, with vacation of two weeks at the holidays). Those who desire can thus attend, during seven months of the year, such a selection of the most useful exercises from the studies of the Full Course as will occupy their time *profitably*.

VI. COURSE IN NATURAL HISTORY AND GEOLOGY.

Professor DANA'S lectures in Geology have always been open to the students of the Scientific School, and of late years he has personally heard their recitations in this study. In 1864, separate Professorships of Zoölogy and Botany were established, and in consequence of the increasing demand for special instruction in these departments of science, a new section of the school has been determined on.

The instruction in Geology continues as heretofore. The instruction in Zoölogy includes,

First—Courses of Lectures during the second and third terms of the Junior year, on Structural and Systematic Zoölogy; and during the first term of the Senior year, on general and applied Entomology and other special subjects.

Second—Direct practical instruction to special zoölogical and geological students, in the Zoölogical Laboratory, where they are taught to prepare and arrange collections of various animals, and, by making critical identifications, to become acquainted with scientific literature, and to make dissections in studying comparative anatomy and embryology. They are also, when sufficiently advanced, encouraged to make original investigations. For these purposes, specimens, both recent and fossil, belonging to the College Museum, are made use of as may be required.

Third—Zoölogical Excursions in connection with the lectures are instituted during the warmer months, to afford the students opportunities to collect and observe the habits of both land and marine animals, including those that live only in deep water, and are obtained by dredging. By these excursions several thousand specimens were added to the College Museum last year.

In the temporary absence of the Professor of Botany, the simple general announcement is made, that facilities are afforded for the general or special study of Botany. Two extensive herbaria, besides microscopes and other instruments of research, are in the possession of the professors in this department, which are accessible to such students. The Flora of the region is rich, embracing both land and marine plants, and frequent excursions are made during the summer under the direction of the instructors.

Regular students in this section are required, as in the others, to complete the studies of the Freshman year, and in addition they should have a knowledge of Latin and Greek.

PROGRAMME OF STUDIES.

Freshman Year (see page 21.)

Junior Year.

FIRST TERM.

Zoölogy—Daily Laboratory instruction; Zoölogical Excursions. *Chemistry*—Academical Lectures. *French*—Fasquelle's Course. *German*—Selections.

SECOND TERM.

Zoölogy and Paleontology—Laboratory Practice, Lectures. *Physical Geography*—Lectures and Recitations. *Chemistry*—Laboratory Practice. *French and German*—continued.

THIRD TERM.

Zoölogy and Paleontology—Laboratory Practice, Lectures, Excursions (land and marine). *Botany*—Preparation of Herbarium, Excursions. *Mineralogy*—Dana, Lectures and Practical Exercises. *French* or *German*, continued. *Drawing*—Free Hand Practice.

Senior Year.

FIRST TERM.

Zoölogy and Paleontology—Laboratory Practice, Lectures, Excursions. *Geology*—Dana's Manual, Excursions. *Meteorology*—Academical Lectures. *French* or *German*—Selections.

SECOND TERM.

Zoölogy and Paleontology—continued. *Geology*—Dana, Recitations and Lectures. *Anatomy and Physiology*—Academical Lectures. *French* or *German*—Selections.

THIRD TERM.

Zoölogy and Paleontology—continued, with Excursions. *Photography*—Practical Instruction. *Preparation of Thesis. Examinations* in the studies of the course. *French and German*—continued.

The Zoölogical and Paleontological collections in the College Museum are already quite extensive, although but partially arranged for want of room, and they are rapidly increasing. The growth of the museum would be still more rapid were ample means available to pay the expenses of their proper preservation. At present we must depend largely upon the liberality of individuals for aid in this respect, as well as for donations of specimens.

A large amount of time is constantly required to scientifically arrange and care for the collections now on hand and those constantly arriving through the system of exchanges already instituted and donations from friends of the College. In this work, the extent of which can be but partially inferred from the number of specimens received during the

past eighteen months amounting to over 100,000, Mr. F. H. Bradley and Mr. S. I. Smith, students in this department, have rendered very important assistance, besides making extensive collections themselves. Mr. Bradley has been absent upon three extended collecting tours,—one to Western New York in 1864, and another to the Mississippi valley in 1865, to collect fossils. At the present time he is collecting marine animals, &c., at Panama. The expenses of these collections have been paid by generous friends of Science. Mr. Smith has made very large collections of beautifully prepared insects during the two summers past, which he is now scientifically arranging for the museum.

VII. SELECT COURSE.

The select course, as its designation indicates, includes a selection from the other courses of study, and also such special instruction as will tend to furnish a good degree of intellectual training and prepare the scholar for higher studies or for the active duties of life. Although the instruction is chiefly scientific and mathematical, yet linguistic and philosophical studies receive a considerable share of attention. It is designed to make this course a valuable means of preparation for advanced scientific studies, and it is hoped that especially the younger students who may avail themselves of its advantages will do so with the intention of going forward to pursue still higher branches of learning. Students who enter upon the other sections of the school having that acquaintance with French and German, that skill in mathematics, and that introductory knowledge of the natural sciences, which the select course offers, will pursue their special professional studies with peculiar advantages.

The students in this section have access to the lectures of President Woolsey and other instructors in the academical department.

PROGRAMME OF STUDIES.

Freshman Year (see page 21.)

Junior Year.

FIRST TERM.

Mechanics—Peck's Elements. *History*—Weber's Outlines, with occasional use of Gibbon, Hume, Robertson, etc. *Agricultural Chemistry. German*—Selections. *French*—*Fasquelle's Course.*

SECOND TERM.

Astronomy—Norton's Astronomy, with practical problems. *Agricultural Chemistry*. Lectures. *Physical Geography*—Lectures and Recitations. *Zoölogy*—Lectures. *History*—Weber's Outlines, etc. *German*—Selections. *French*—Fasquelle, Selections from Classic Authors.

THIRD TERM.

Botany—Preparation of Herbarium (continued). *Zoölogy*—Excursions and Lectures. *Mineralogy*—Dana. *Literature*—Critical study of classical English authors. *Drawing*—Free Hand, and Architectural. *French*—Selections.

Senior Year.

LANGUAGE.—*French or German*, continued. Lectures on Language and Linguistic Ethnology. Compositions.

NATURAL SCIENCE.—*Botany and Zoölogy*, continued. *Geology*—Recitations and Lectures. *Meteorology*—Lectures. *Human Anatomy and Physiology*—Lectures. *Astronomy*—Lectures.

PHILOSOPHY AND HISTORY.—Lectures and recitations, in *History and Political Philosophy, International Law, Political Economy, Ethics, and Metaphysics.*

Examination for the degree. Preparation of a graduating thesis.

Prizes.

A sum of money has been placed in the hands of the officers of the school by the Berzelius Trust Association, to be bestowed in prizes within the next two years for the best essays on scientific themes presented to the Faculty. Two prizes will be annually awarded—the first, $30 in gold; and the second, $20 in gold. Professor Silliman has likewise offered an annual gift of $100 in gold, for three years, to be awarded for the best chemical researches.

Terms and Vacations.

The College Commencement is held on the last Thursday in July of each year. The first term begins seven weeks from the day before Commencement and continues fourteen weeks; the second begins on the first Wednesday in January and continues fourteen weeks; the third, of twelve weeks, begins on the first Wednesday in May and continues till Commencement. The intervening periods, of seven, two, and three, or, as the case may be, four weeks, are assigned for vacations.

APPOINTMENT OF STATE STUDENTS.

Announcement of the Appointing Board.

1. By appropriating to the Sheffield Scientific School of Yale College the income of certain funds derived from the sale of United States lands, the State of Connecticut has provided for the gratuitous instruction of a number of pupils in the various departments of the school.

II. The persons to receive this free tuition are to be selected from the candidates who offer themselves, by an Appointing Board, consisting of the Governor, the Lieut.-Governor, the three senior Senators, the Secretary of the State Board of Education, and the Secretary of the Sheffield Scientific School.

III. This privilege of free instruction must be assigned in accordance with the following principles, viz:

1. The candidates for appointment must be citizens of this State.

2. Preference will be given to such as are "fitting themselves for agricultural and mechanical or manufacturing occupations, who are or shall become orphans through the death of a parent in the naval or military service of the United States, and next to them such as are most in need of pecuniary assistance."

3. The appointments must be distributed as far as practicable among the several Counties of the State in proportion to their population.

IV. Candidates nominated by the Appointing Board are to be admitted to the school "upon the same terms and are to be subject to the same rules and discipline as the other pupils of the school, with the single exception that they shall not pay anything for their instruction."

V. The Appointing Board will meet in New Haven on Tuesday, July 24th, and also on Wednesday, September 12th, 1866. Persons desiring to avail themselves of the bounty of the State may apply, in writing, previous to the meeting of the Board, to the Secretary, who will furnish a printed form of application, to be filled up by each candidate, and will present all applications to the Board for their decision.

GEO. J. BRUSH,
Secretary of the Appointing Board.

OFFICERS OF THE SCHOOL.

Corporation,

THE PRESIDENT AND FELLOWS OF YALE COLLEGE.

Visitors on the part of the State of Connecticut,

THE GOVERNOR, THE LIEUTENANT-GOVERNOR, THE THREE SENIOR SENATORS, AND THE SECRETARY OF THE STATE BOARD OF EDUCATION.

President,*

Rev. THEODORE D. WOOLSEY, DD., LL.D.

Professors,

WILLIAM A. NORTON, M.A.,	*Civil Engineering and Mathematics.*
JAMES D. DANA, LL.D.,	*Geology and Mineralogy.*
BENJAMIN SILLIMAN, M.D.,	*General and Applied Chemistry.*
Rev. CHESTER S. LYMAN, M.A.,	*Industrial Mechanics and Physics.*
WILLIAM D. WHITNEY, Ph.D.,	*Modern Languages.*
GEORGE J. BRUSH, M.A.,	*Mineralogy and Metallurgy.*
DANIEL C. GILMAN, M.A.,	*Physical Geography.*
SAMUEL W. JOHNSON, M.A.,	*Analytical and Agricultural Chemistry.*
WILLIAM H. BREWER, M.A.,	*Agriculture.*
ALFRED P. ROCKWELL, M.A.,	*Mining.*
DANIEL C. EATON, M.A.,	*Botany.*
ADDISON E. VERRILL, B.S.,	*Zoölogy.*

Instructors,

MARK BAILEY, M.A.,	*Elocution.*
LOUIS BAIL,	*Drawing and Designing.*
PETER COLLIER, M.A.,	*Chemistry.*
JOHN AVERY, M.A.,	*Physics, etc.*
JAMES B. STONE, Ph.B.,	*Mathematics.*
BEVERLY S. BURTON, Ph.B.,	*Chemistry.*
FREDERICK F. THOMAS, Ph.B.,	"
JOHN J. MATTHIAS, M.A.,	"

* The President and Professors constitute the Governing Board of the School.

STUDENTS—1865-6.

Wellington Miles Andrew,	*Orange.*
Leonard Strong Austin,	*Stratford.*
Henry Norris Baker,	*Brooklyn, N. Y.*
George Franklin Bailey,	*Centre Rutland, Vt.*
George William Baird, B.A.	*Milford.*
Samuel Atkins Barbour,	*Bristol.*
Volney Giles Barbour,	*Bristol.*
Charles Yale Beach,	*Brooklyn, N. Y.*
Frederick C. Beach,	*Stratford.*
John Kennedy Beeson,	*Uniontown, Pa.*
James DeTrafford Blackstone,	*Norwich.*
Frank Howe Bradley, B.A.	*New Haven.*
Eugene S. Bristol,	*New Haven.*
Beverly S. Burton, PH.B.	*Philadelphia, Pa.*
Alfred Caldwell,	*Honolulu, Sandwich Isl'ds.*
Benjamin Dutton Candee,	*Branford,*
Curtis Chapman,	*Peekskill, N. Y.*
James W. Chapman,	*Castile, N. Y.*
Samuel Hosmer Chittenden,	*Madison.*
Albert Gardiner Clark,	*Cincinnati, O.*
Frederick William Clarke,	*San Francisco, Cal.*
George Douglas Coit,	*Norwich.*
Peter Collier, M.A.	*Chittenango, N. Y.*
Robert L. Crooke,	*Flatbush, N. Y.*
John Morrison Davis,	*Alleghany City, Pa.*
Charles Richards Dodge,	*Washington, D. C.*
William F. Dow,	*Detroit, Mich.*
Henry Marchant Dudley,	*Whitinsville, Mass.*
Adrian J. Ebell,	*New Haven.*
Barton Darlington Evans,	*West Chester, Pa.*
Lyman Stewart Ferry,	*New Haven.*
Edward Forsyth Finney,	*St. Louis, Mri.*
James Fowler,	*Westfield, Mass.*

John Henry Fowler,	*East Haven.*
Charles Henry Gauss,	*St. Charles, Mri.*
Charles Starr Gardiner,	*Milwaukee, Wis.*
Alfred William Geist,	*Boston, Mass.*
John H. Grove,	*Danville, Pa.*
Joshua Comly Grove,	*Danville, Pa.*
Peter H. Grove,	*Danville, Pa.*
Robert Michael Grove,	*Danville, Pa.*
Dudley Chase Haskell,	*Lawrence, Kansas.*
George Wesson Hawes,	*Worcester, Mass.*
John Corey Hersey,	*Bridgeport.*
Joseph Courten Hornblower,	*Paterson, N. J.*
Charles Henry Hubbard,	*Sandusky, O.*
George Anson Jackson,	*North Adams, Mass.*
Wilford Linsly,	*New York City.*
Francis Englesby Loomis, B.A.	*New Haven.*
James Joseph Lucas, B.A. Center College, Ky.,	*Danville, Ky.*
George Richards Lyman,	*Northampton, Mass.*
Alexander Ufford McAlister,	*New Haven.*
James A. Macdonald, B.A. Columb.	*Flushing, N. Y.*
Joseph Scott McKell,	*Chillicothe, O.*
Thomas Henry Mason,	*New York City.*
John J. Matthias, M.A. N. Y. Univ.	*Newark, N. J.*
William Gilbert Mixter,	*Rock Island, Ill.*
Charles Kinney Needham,	*Louisville, Ky.*
William Harmon Niles,	*Southampton, Mass.*
Frederick George Noonan,	*Milwaukee, Wis.*
Alexander S. Palmer, PH.B.	*Stonington.*
George Fowler Parmelee,	*New Haven.*
Lyman B. Parshall,	*Farmer, N. Y.*
Lucien Tudor Platt,	*Waterbury.*
George Brinkerhoff Pumpelly,	*Owego, N. Y.*
William Wallace Redfield,	*Philadelphia, Pa.*
Henry Willis Reeve,	*Brooklyn, N. Y.*
Alexander Renick,	*Chillicothe, O.*
William N. Rice, B.A. Wesleyan Univ.	*Springfield, Mass.*
John Arnold Rockwell,	*Norwich.*

Joseph Perkins Rockwell,	*Norwich.*
Charles Greene Rockwood, B.A.	*Newark, N. J.*
Charles Shepard Rodman,	*New Haven.*
Charles Joseph Sheffield,	*New Haven.*
Theron Skeel, PH.B.	*Newburgh, N. J.*
Sidney Irving Smith,	*Norway, Me.*
James B. Stone, PH.B.	*Boonton, N. J.*
Lewis Bridge Stone,	*New York City.*
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John Jacob Taylor,	*Newport, R. I.*
Frederic Terry,	*New Haven.*
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Benjamin Pomeroy Wheeler,	*North Stonington.*
William Robert White,	*Philadelphia, Pa.*
Joseph Thompson Whittlesey,	*New Haven.*
Luther Hodges Wood,	*West Haven*

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SECOND ANNUAL REPORT

OF THE

SHEFFIELD SCIENTIFIC SCHOOL

OF YALE COLLEGE:

INCLUDING

I. THE REPORT OF THE VISITORS ON THE PART OF THE STATE OF CONNECTICUT;

II. THE REPORT OF THE GOVERNING BOARD AND FACULTY OF THE SCHOOL;

III. A STATEMENT OF THE ESTABLISHED COURSES OF STUDY.

1866-7.

NEW HAVEN:
PRINTED BY E. HAYES, 426 CHAPEL ST.
1867.

State Board of Visitors, and Appointing Board.

Till May, 1866.

GOVERNOR,

His. Exc. WILLIAM A. BUCKINGHAM, Norwich.

LIEUT. GOVERNOR,

His Honor ROGER AVERILL, Danbury.

STATE SENATORS,

Hon. EDWARD I. SANFORD, New Haven,	4th District.
Hon. ORLANDO T. HODGE, Robertsville,	15th "
Hon. CHARLES A. ATKINS, Mansfield,	21st "

SECRETARY OF THE STATE BOARD OF EDUCATION,

Prof. DANIEL C. GILMAN, New Haven.

SECRETARY OF THE SHEFFIELD SCIENTIFIC SCHOOL,

Prof. GEORGE J. BRUSH, New Haven.

Till May, 1867.

GOVERNOR,

His Exc. JOSEPH R. HAWLEY, Hartford.

LIEUT. GOVERNOR,

His Honor OLIVER F. WINCHESTER, New Haven.

STATE SENATORS,

Hon. JASPER H. BOLTON, Stafford,	20th District.
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Hon. H. LYNDE HARRISON, Branford,	6th "

SECRETARY OF THE STATE BOARD OF EDUCATION,

Rev. BIRDSEY G. NORTHROP, New Haven.

SECRETARY OF THE SHEFFIELD SCIENTIFIC SCHOOL,

Prof. DANIEL C. GILMAN, New Haven.

Corporation of Yale College.

PRESIDENT,

Rev. THEODORE D. WOOLSEY, D.D., LL.D.

FELLOWS,

His Exc. JOSEPH R. HAWLEY, Hartford.
His Honor OLIVER F. WINCHESTER, New Haven.
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TREASURER,

HENRY C. KINGSLEY, M.A.

TREASURER'S ASSISTANT,

LUCIUS W. FITCH, M.A.

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REPORT OF THE BOARD OF VISITORS.

To the General Assembly of the State of Connecticut:

THE undersigned, constituting the State Board of Visitors of the Sheffield Scientific School of Yale College, and also, with the Secretary of the School, the Board for the Appointment of State Students, respectfully report that they have held three regular meetings during the year at New Haven, have acted upon all the applications of candidates for State Scholarships submitted to them, and have made a personal examination of the operations of the School. At a meeting held February 14, 1867, most of the Professors of the School were present, and they laid before this Board extended statements respecting the progress of the several sections, and of the general interests of the institution. These statements will be printed with this report for the information of the Legislature.

Particular attention is called to the munificence of Mr. Sheffield, whose recents gifts it will be seen have amounted to sixty thousand dollars, and whose entire donations to this institution have not been less than one hundred and sixty thousand dollars. Other generous gifts have been bestowed upon Yale College, in the benefits of which the Scientific School will share, and many valuable donations have been made to its special collections and library. The rapid growth of the School, evinced by the increasing facilities for instruction, and the increasing number

of scholars, confirms the wisdom of the General Assembly in its disposition of the National gift. While some other States have been involved in tedious and embarrassing delays, or have failed to comply with the conditions imposed by Congress, Connecticut has at once been able to reap the advantages of a well organized School of Science. By the wise combination of public and private munificence, and by the harmonious union of a new department with a time-honored and conservative seat of learning, far greater benefits have been secured to the community than could have been expected from any other course.

We repeat the expressions of confidence and satisfaction which came from the Visitors of the previous year; and we commend this prosperous institution to the further liberality of our wise and wealthy citizens.

JOSEPH R. HAWLEY,
OLIVER F. WINCHESTER,
JASPER H. BOLTON,
LEMUEL STOUGHTON,
H. LYNDE HARRISON,
BIRDSEY G. NORTHROP,
Board of Visitors.

STATEMENT

RESPECTING THE PROGRESS OF

THE SHEFFIELD SCIENTIFIC SCHOOL

OF YALE COLLEGE,

Presented to the State Board of Visitors,

At their Annual Meeting, February 14, 1867,

BY THE

GOVERNING BOARD AND FACULTY OF THE INSTITUTION.

Governing Board of the Sheffield Scientific School.

PRESIDENT WOOLSEY.

PROFESSORS DANA, NORTON, LYMAN, SILLIMAN, WHITNEY, BRUSH, GILMAN, JOHNSON, BREWER, ROCKWELL, EATON, MARSH, AND VERRILL.

ANNUAL STATEMENT FOR 1866--7.

The Sheffield Scientific School, during the twelve months past, has not only been the recipient of important specific donations, but, in common with all the departments of the University to which it belongs, it has shared in other more general benefactions. The year will be memorable in the history of Yale College for the opening of the Yale School of the Fine Arts, the endowment of the Peabody Museum, and the enlargement of Sheffield Hall. All these establishments afford new evidence of the confidence which is placed in the Corporation of Yale College as trustworthy guardians of important interests, and give reason to believe that New Haven will be in the future, as it has been in the past, a favored seat of Literature and Science.

The group of institutions which are associated under the general designation of "Yale College," and are bound together under the control of one body of trustees, is now so complex, that the various members cannot rightly be regarded as isolated or distinct. They have a community of interests and aims; their courses of study are partially coincident; the same instructors are connected with different faculties; all have a common interest in the growing collections of Books, of Apparatus, of works of Art, and of objects in Natural History; and in many other respects the several colleges are so linked together that the growth and prosperity of each department is conducive to the welfare of all.

Accordingly, in referring to the opportunities now afforded for scientific education, it will be necessary to exhibit some of the advantages which accrue to the Scientific School from a connection with the older College. This is done without any desire to claim for the School the reputation or credit which belongs to the University as a whole or to any other department. It is simply meant to exhibit the means of instruction which are here at command.

I. Mr. Sheffield's continued munificence.

When the last annual statement respecting the Sheffield Scientific School was presented by the Governing Board to the Visitors on the part of the State of Connecticut, the enlargement and alteration of Sheffield Hall were in progress, at the expense of the same benefactor who had given us this edifice six years before. Within the past twelve months these improvements have been completed.

Before referring to any other topics, the officers of the school, therefore, desire in this public manner to acknowledge with gratitude the continued munificence of JOSEPH E. SHEFFIELD, Esq., of New Haven. His successive donations to this department of Yale College, amounting to more than $160,000, have been so timely, and have moreover been bestowed with so much discernment respecting the needs of a School of Science, that the community will be under lasting and manifold obligations to his enlightened liberality. His recent gifts, including the enlargement and alteration of Sheffield Hall, the purchase of astronomical instruments, and the establishment of a library fund, have reached the sum of SIXTY THOUSAND DOLLARS. The value of his personal supervision of this outlay cannot be estimated in figures. Regard for the modesty which has been characteristic of the donor in all these large gifts precludes us from saying more than that his name will always be held in honor in connection with the institution which his liberality is building up.

II. Description of Sheffield Hall, as enlarged and refitted.

In view of the recent changes, the Board believe that a description of the building which is owned and occupied by the School will be acceptable at the present time to the State Visitors and to the public. By means of the diagrams which accompany this statement, a clear idea may be obtained of a somewhat complicated structure, which has grown with the growth of the institution, and is now conveniently adapted to the requirements of the various sections into which the School is divided.

Sheffield Hall is situated in Grove street, fronting College *street, nearly a quarter* of a mile north of the College square.

It is built of stone and brick covered with stucco, and consists of a principal three story structure, and two wings (each of two stories), now connected in the rear by another three story building. There are three public entrances on Grove street, of which the central one is the chief, leading to all portions of the building; the eastern door leads to the principal room of the Engineering Class and to the Metallurgical Museum above it; and the western door leads to the Chemical Laboratory.

There are two projecting towers—one in front, at the main entrance, and one at the northwest corner of the building. The principal tower in front is ninety feet high and sixteen feet square. In the second and third stories are studies for two of the professors. Above these rooms is the belfry-clock with its four dials, and surmounting the structure is a revolving turret in which the equatorial telescope is placed. A description of this instrument and of the mode in which it is mounted will be subsequently given.

The tower clock was made by Messrs. E. Howard & Co., of Boston. It has a wooden pendulum rod eight feet in length, with a zinc compensation-tube below the bob, specially ordered for this clock. The bob is of cast iron, and about twice as heavy as those usually furnished by the makers. The rate has thus far proved to be nearly uniform and quite satisfactory. The clock is set anew to zero, whenever its error amounts to half a minute. This has occurred but twice since August last. The hours are struck on a fine-toned bell of 675 lbs. weight, suspended in a separate bell-tower on the main roof, some twenty-five feet from the clock.

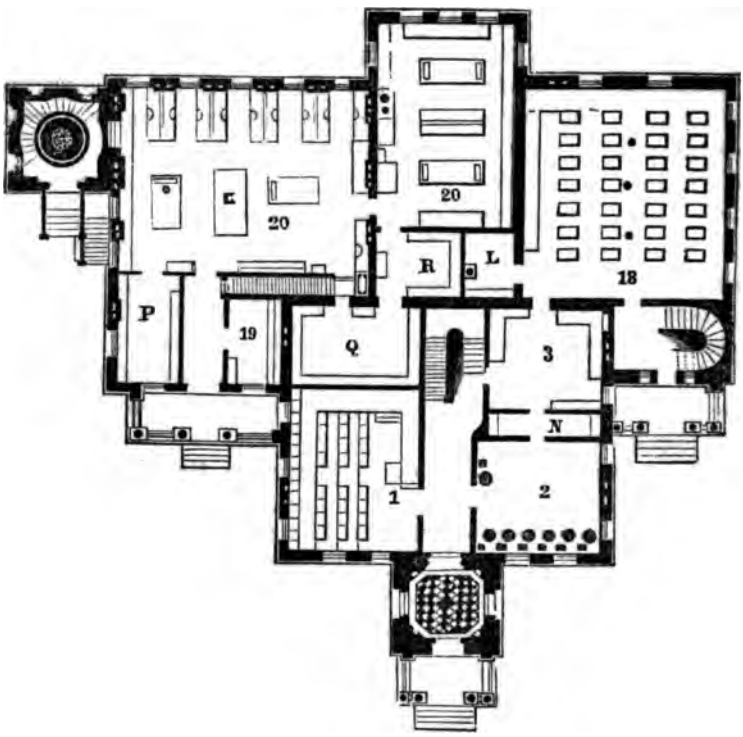
The northwestern tower, sixteen feet square and fifty feet high, was built for the reception of a Meridian Circle, a particular account of which will be found below.

The extreme length of the edifice from the western tower to the east side is 117 feet; and the extreme depth is 112 feet. The three cuts which are given on the following pages exhibit the arrangement of rooms on each of the three stories. The basement, which is not here represented, contains a Janitor's apartment and a metallurgical laboratory, in addition to the hot-air furnaces, store rooms, etc.

The architect under whose direction the enlargement was carried forward was Henry Austin, Esq., the masonry was by Messrs. Perkins & Chatfield, and the carpentry by Charles Thompson.

SHEFFIELD HALL.

PLAN OF THE FIRST STORY.



Chief entrance.

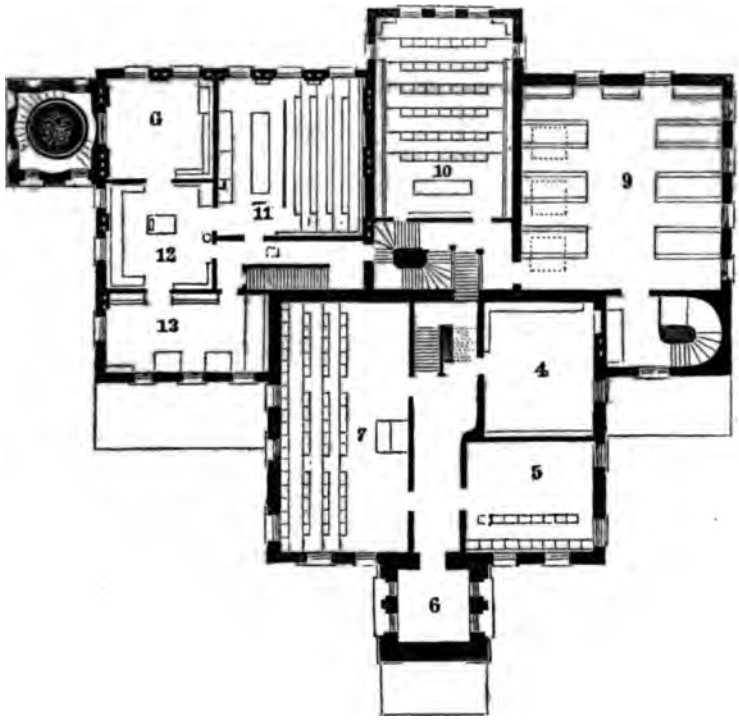
Designation of the Rooms.

(The numbers and letters correspond with those which are affixed to the doors of the several apartments.)

No. 1, Recitation-room, in Mathematics, Physics, etc.
" 2, " " " Engineering, etc.
" 3, Exhibition-room for engineering models, etc.
" 18, Drawing-room for the Engineering and other classes.
" 19, Chemical Assistant's office.
" 20, 20, Chemical Laboratory.
L, Closet.
P, Balance-room.
Q, Store room.
R, Chemical reagent room.

SHEFFIELD HALL.

PLAN OF THE SECOND STORY.



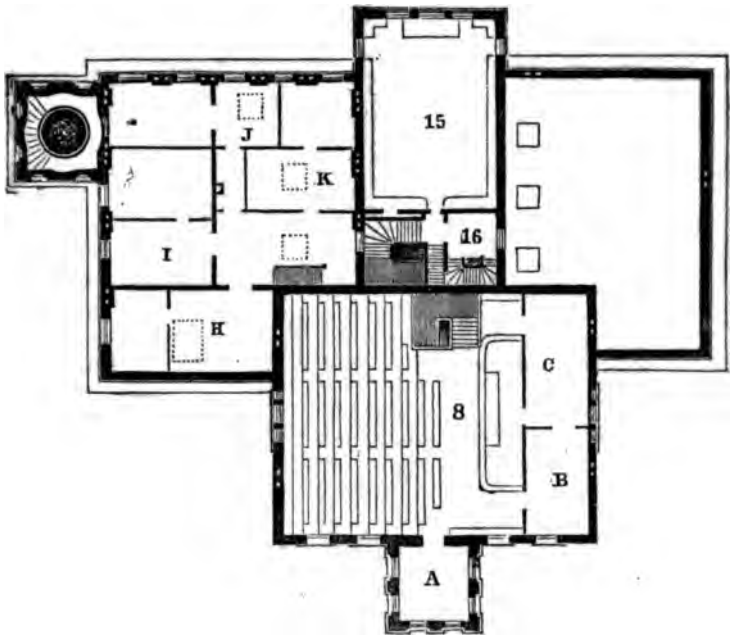
Designation of the Rooms.

(The numbers and letters correspond with those which are affixed to the doors of the several apartments.)

No. 4, Prof. Brewer's study.
" 5, Recitation-room in Physical Geography, etc.
" 6, Prof. Rockwell's study.
" 7, Recitation-room in Modern Languages, Mechanics, etc.
" 9, Metallurgical Museum.
" 10, Agricultural Lecture-room.
" 11, Chemical Lecture-room.
" 12, Private Chemical Laboratory.
" 13, Prof. Brush's study.
G, Prof. Johnson's study.

SHEFFIELD HALL.

PLAN OF THE THIRD STORY.



Designation of the Rooms.

(The numbers and letters correspond with those which are affixed to the doors of the several apartments.)

No. 8, Public Lecture-room.
" 15, Library.
" 16, Librarian's room.
A, Prof. Lyman's study.
B and C, Apparatus-rooms.
H, Photographic Laboratory.
I, J, Dormitories.
K, Store-room.

The principal Observatory is reached by the stair case which leads to the Library-room (No. 15), and is thence continued till it *meets a passage* way leading into the tower.

III. The Peabody Museum of Natural History.

It is already well known that GEORGE PEABODY, Esq., of London, in October last made the generous donation of one hundred and fifty thousand dollars to found "in connection with Yale College" a Museum of Natural History. Although this munificent gift is designed to benefit all departments of the University, it will obviously and necessarily be of more immediate advantage to the students of Natural Science connected with this school; and hence the donor's letter to his Trustees, and the accompanying instrument of gift, may be fitly given here.

MR. PEABODY'S LETTER.

NEW YORK, OCT. 22, 1866.

To Professor JAMES. D. DANA, Hon. JAMES DIXON, Hon. ROBERT C. WINTHROP, Professor BENJAMIN SILLIMAN, Professor GEORGE J. BRUSH, Professor OTHNIEL C. MARSH, and GEORGE PEABODY WETMORE, Esq.

GENTLEMEN:—With this letter I enclose an instrument giving to you one hundred and fifty thousand dollars ($150,000), in trust for the foundation and maintenance of a MUSEUM OF NATURAL HISTORY, especially of the departments of Zoology, Geology, and Mineralogy, in connection with Yale College.

I some years ago expressed my intention of making a donation to this distinguished institution, and convinced as I am of the importance of the natural sciences, and of the increasing interest taken in their study, it now affords me great pleasure to aid in advancing these departments of knowledge.

The rapid advance which natural science is now making renders it necessary to provide for the future requirements of such a museum, as well as its present wants, and I trust that the portion of the fund designed for this purpose will be found sufficient.

On learning of your acceptance of this trust, and of the assent of the President and Fellows of Yale College to its conditions, I shall be prepared to pay over to you the sum I have named, and I may then have some additional suggestions to make, in regard to the general management of the trust.

Confident that under your direction this trust will be faithfully and successfully administered,

I am, with great respect, your obedient servant,

GEORGE PEABODY.

THE INSTRUMENT OF GIFT.

I hereby give to JAMES DWIGHT DANA, of New Haven, Conn.; JAMES DIXON, of Hartford, Conn.; ROBERT C. WINTHROP, of Boston, Mass.; BENJAMIN SILLIMAN, of New Haven, Conn.; GEORGE JARVIS BRUSH, of New Haven, Conn.; OTHNIEL CHARLES MARSH, of New Haven, Conn.; and GEORGE PEABODY WETMORE, of Newport, R. I., on his attaining his majority, *the sum of one hundred* and fifty thousand dollars, to *be by them or their successors held* in trust to found and maintain a

Museum of Natural History, especially of the departments of Zoology, Geology and Mineralogy, in connection with Yale College, in the city of New Haven, State of Connecticut.

Of this sum I direct that my said trustees devote a part, not to exceed one hundred thousand dollars, to the erection, upon land to be given for that purpose, free of cost or rental, by the President and Fellows of Yale College, in New Haven, of a fire-proof museum building, adapted to the present requirements of these three departments of science, but planned with especial reference to its subsequent enlargement; the building, when completed, to become the property of said college for the uses of this trust, and none other.

I further direct that the sum of twenty thousand dollars be invested, and accumulate as a building fund until it shall amount to at least one hundred thousand dollars, when it may be employed by my said trustees, or their successors, in the erection of one or more additions to the museum building, or in its final completion; the land for the same also to be provided free of cost or rental by the President and Fellows of Yale College, in New Haven, and the entire structure when completed to be the property of Yale College, for the uses of this trust and none other.

I further direct that thirty thousand dollars, the remaining portion of this donation, be invested, and the income from it be expended by my said trustees, or their successors, for the care of the museum, increase of its collections, and general interests of the departments of science already named; the part of the income remaining after providing for the general care of the museum to be apportioned in the following manner: three sevenths to zoology, three sevenths to geology, and one seventh to mineralogy; the said collections, as well as the museum building, to be exclusively for the benefit of the various departments of said college.

The Board of Trustees I have thus constituted shall always be composed of seven persons, of whom not more than four shall at any one time be members of the Faculty of Yale College. They shall have the general management of the museum, keep a record of their doings, and annually prepare a report setting forth the condition of the trust and funds, and the amount of income received and paid out by them during the previous year. This report, signed by the trustees, shall be presented to the President and Fellows of Yale College, in New Haven, at their annual summer session, and be by them filed in the archives of said college.

In the event of the death or resignation of either of my said trustees, I direct that his successor be the Governor of Connecticut, who, *ex officio*, shall forever afterward be a member of the Board. Any other vacancy that may occur in the Board of Trustees, either by resignation or by death, shall be filled by the remaining trustees within a reasonable time after such vacancy shall have occurred.

I give to my said trustees, and their successors, the liberty to appoint a treasurer, and to enter into any agreements with the President and Fellows of Yale College, not inconsistent with the terms of this trust, which may in their opinion be expedient.

GEORGE PEABODY.

New York, Oct. 22, 1866.

This generous donation provides for one great and pressing want of the University—a fire-proof Museum building for preserving the extensive and valuable collections which have been accumulating during the last half-century, and are now rapidly increasing. It is understood to be the intention of the Trustees to commence the erection of the first wing of the Museum at an early day. When completed, this part will, it is thought, be amply sufficient for the requirements of the immediate future, or until the reserved building-fund shall have increased sufficiently to provide for the erection of the main or central building; and this in turn will serve until the completion of the whole structure.

Students of Natural History in all departments of Yale College, and in all time to come, will be grateful to Mr. Peabody for thus rendering secure the collection and preservation of such a Museum as the institution has long been in need of.

IV. The Yale School of the Fine Arts.

Early last autumn the edifice was finished which has been erecting on the College square during two years past as the Yale School of the Fine Arts. The founder, AUGUSTUS R. STREET, Esq., of New Haven, did not live to see the completion of his munificent gift. The building affords ample facilities for the exhibition of works of art and for the instruction of classes in the various arts of design. As the council of the School have not yet made an announcement of their plans, it would be premature in this place to do more than express a lively appreciation of the value of Mr. Street's benefaction, and the belief that the complete organization of such a School of Design as he contemplated would be specially advantageous to the students of natural history, and of engineering and architecture, in this department, as well as to those who intend to make some branch of the Fine Arts a profession.

Prof. BAIL, who has been the Instructor of Drawing in the Sheffield School for several years past, is now occupying rooms in the new Art building, and a number of our students are receiving his instructions in that place.

V. The Commencement of a Library.

After completing the enlargement of our building, Mr. Sheffield fitted up one of the most spacious rooms as a Library and Reading Room, providing for *it not only the* necessary shelves, and the

books of record, but also the carpet, table, desk, and seats—all of them of choice material and design. According to his expectation, this room has been used for the stated meetings of the Faculty, the Board of Visitors, and the Connecticut Academy of Arts and Sciences. The Trustees of the Peabody Museum and also the American Oriental Society met here in October last.

Mr. Sheffield also presented to the Corporation of Yale College, for the use of the School, the sum of ten thousand dollars, the income of which is to be applied to the purchase of books for this department of the College. The following is his letter:

NEW HAVEN, APRIL 20th, 1866.

TO THE PRESIDENT AND FELLOWS OF YALE COLLEGE:

Dear Sirs,—I present to Yale College, for the use and benefit of the "Sheffield Scientific School of Yale College," the enclosed certificate of ten thousand dollars in the stock of the New Haven and Northampton R. R. Company, the income of which, forever, is to be invested in such books as the Faculty, or Board of control, of said Scientific School, or the Library committee thereof, shall deem most useful to said school. Said income (which may be relied upon as six per cent. per annum, free of taxation) is to be invested annually, or from time to time, as said library committee may find most expedient and useful.

The books so purchased shall be plainly labelled, either on the cover or inside, thus: "*Library of the Sheffield Scientific School of Yale College, Sheffield Collection;*" and shall, as fast as purchased, be registered in a book prepared for that purpose, stating the date of purchase, title of the work, number of volumes, and the cost, so as to form a running catalogue of the collection and its cost.

I ask no further acknowledgment of this donation than that this letter be transcribed into the book prepared for the registry of this infant library, and that its receipt be noted in the records of the college.

I am, very respectfully, your obedient servant,

JOSEPH E. SHEFFIELD.

By the liberality of a few friends of the institution, the additional sum of two thousand dollars was contributed, to be immediately expended in books which are needed as the nucleus of a Reference Library. These subscriptions were as follows:

Hon. WILLIAM W. BOARDMAN,	New Haven,	$250.00
JARVIS BRUSH, Esq.,	New Haven,	100.00
TREDWELL KETCHAM, Esq.,	New York,	500.00
Messrs. PERKINS & CHATFIELD,	New Haven,	200.00
JOSEPH SAMPSON, Esq.,	New York,	500.00
HENRY TROWBRIDGE, Esq.,	New Haven,	100.00
Hon. HARMANUS M. WELCH,	New Haven,	100.00
JOHN D. WHEELER, Esq.,	New Haven,	250.00
		$2,000.00

On taking possession of the Library room, the officers of the school also presented to the library important series of books.

The following periodicals are now received in the reading room. Many similar journals, which might be looked for in this list, are received in part by the Library of Yale College and in part by the Professors privately.

AMERICAN.

Title.	How received.
American Journal of Science and Arts.	By gift of the Editors.
Scientific American.	"
American Artisan.	By subscription.
American Rail Road Journal.	"
American Gas Light Journal.	"
American Journal of Mining.	"
American Journal of Pharmacy.	"
American Farmer.	By gift of Messrs. Silliman & Dana.
Horticulturist.	By subscription.
American Agriculturist.	By gift of the Publishers.
Journal of the N. Y. State Agricultural Society.	By gift of the Society.
American Journal of Horticulture.	By subscription.
New England Farmer.	"
Southern Planter.	By gift of the Publishers.
Practical Entomologist.	By subscription.
California Mining and Scientific Press.	By gift of Prof. Brewer.
California Farmer.	By gift of the Editors.
Journal of the Franklin Institute.	By subscription.
American Naturalist.	"
Journal of Conchology.	"
Proceedings of Boston Society of Natural History.	By gift.
Transactions of the Connecticut Academy.	By gift of the Academy.
American Publishers' Circular.	By gift of the Publishers.

BRITISH.

Civil Engineer and Architect's Journal.	By subscription.
Practical Mechanic's Journal.	"
Engineer.	"
Mining Journal.	"
Farmer's Magazine.	"
Gardeners' Chronicle.	"
Zoölogist.	"
Ibis.	"
Annals and Magazine of Natural History.	"
Monthly Notices of the Astronomical Society.	"
Mechanics' Magazine.	By gift of Messrs. Silliman & Dana.
British Journal of Photography.	"
Ironmonger.	"
Journal of the Society of Arts.	"
Journal of the Chemical Society.	By subscription.
Chemical News.	"

CONTINENTAL.

Title.	How received.
Cosmos.	By gift of Messrs. Silliman &
Le Monde.	"
Chemisches Central-Blatt.	By subscription.
Annales de Chimie et de Physique.	"
Zeitschrift für Chemie.	"
Zeitschrift der Oberschlesischen Gesellschaft.	"
Annalen der Landwirthschaft in Preussen.	"
Civilingenieur.	"
Polytechnisches Central-Blatt.	"
Technologiste.	"
Botanische Zeitung.	"
Hedwigia.	"
Zeitschrift für Wissenschaftliche Zoölogie.	"
Journal für Anthropologie.	"
Revue Universelle des Mines.	"
Journal d'Agriculture Pratique.	"
Revue et Magazin de Zoölogie.	"
Annales des Ponts und Chaussées.	"
Moniteur de la Photographie.	By gift of Messrs. Silliman &
Bulletin de la Société Chimique de Paris.	By subscription.

VI. Astronomical Observatory and Instruments.

[In charge of Professor LYMAN.]

The facilities for astronomical observation have been gr increased during the year by the establishment, at Sheffield of an Observatory, furnished with large and valuable instrum Heretofore, the private Observatory of Professor LYMAN ha forded the only means of practical training. With the in ments, fixed and portable, now at command, the student ha needed facilities for observing the heavenly bodies; and alsc practice, whether in the operations of a regular Observatory, those of Astronomical Geodesy.

The Observatory occupies the two towers, each sixteen square, recently added to the edifice. In one of these is mou an EQUATORIAL TELESCOPE; in the other, a MERIDIAN CIR with a SIDEREAL CLOCK; both telescope and circle being recent gifts of Mr. Sheffield.

The Equatorial Telescope, ordered of Messrs. Alvan Clar Sons, of Cambridgeport, in November, 1865, was, early in C ber last, mounted in the revolving turret at the top of the tower, some eighty feet above the ground, where it comman good horizon. It is supported by a freestone pier, six fee height, which stands on a massive floor of masonry arched in *the side walls, just* above the tower clock. Though it thus

takes of whatever motion the tower itself is subject to, from winds and other causes, no noticeable inconvenience has been experienced, or is anticipated, from this source. The floor of the room, which is of wood, immediately above the stone floor, rests only in the outer walls, and does not touch the pier.

The object-glass has a clear aperture of nine inches, and is nine feet ten inches in focal length. The tube, made of pine handsomely finished, and ten inches in diameter, is at once stiff and light. Seven Huygenian eye-pieces give powers ranging from 40 to 620. All but one of these fit also a diagonal eye-tube containing a prismatic reflector. Another diagonal reflector—the first surface of an acute prism of glass—is used in observing the sun, the greater part of whose light and heat is transmitted, while the image formed by the reflected rays is viewed without inconvenience, with the full aperture of the telescope.

The equatorial mounting is the German, or Fraunhofer's—the declination axis carrying a circle of twelve inches diameter, graduated on silver so as to read by two verniers to 10″, and the polar axis carrying an hour circle of nine inches diameter, graduated to minutes of time, and reading by two verniers to five seconds.

Beneath the polar axis, in the curve of the U-shaped iron piece by which that axis is supported, is placed the driving clock. Its going is regulated by a half-second pendulum, and the intermittent motion of the scape wheel is changed into a smooth and equable motion for the telescope by the simple and ingenious device known as "Bond's Spring-Governor."

The performance of the telescope accords with the reputation of its makers. On favorable nights, it shows easily such test objects as δ Cygni, the companion of Sirius, the 6th star in the Trapezium of Orion, and, with more difficulty, γ_2 Andromedæ. The second and third have been seen with the aperture reduced to five inches.

There is used with the telescope a bi-filar position-micrometer, with four eye-pieces, by Dollond.

A very simple observing chair enables the observer to change his position, quickly and easily, to any height required, without leaving his seat.

The revolving turret, resembling in form that of a "Monitor," rests, by a circular rail at its base, on eight grooved iron wheels, nine inches in diameter, the steel journals of which run in boxes of Babbitt's metal. It is turned by a crank, the pinion of which

gears into a rack cast on the circular rail. The opening, th
feet in width, extends entirely across, through the roof and sid
from base to base. It is closed by eight hinged shutters, so c
trolled by rods and levers as to be opened or shut with gr
facility.

The tower connected with the west wing was erected dur
the last summer, specially for the reception of the Meridian Ci
purchased of the U. S. Government, and formerly used in the I
room of the Washington Observatory. This instrument
mounted in September on the massive granite piers, which c
with it, and the bases of which are imbedded in the upper
of a shaft of solid masonry, thirty-six feet in height, nine
diameter at the base, and seven at the top. This shaft ri
independently of the building throughout, from a founda
ten feet below the surface of the ground, and is surrounded,
few inches distance, by a double casing made of tarred felt
matched sheathing boards. It is thus well protected against
den changes of temperature.

The Meridian Circle has a five-foot telescope, with an obj
glass of 3·8 inches aperture, and 58 inches focal length. It
three Ramsden eye-pieces. A diagonal eye-piece in addition
been ordered, for more conveniently observing objects at l
altitudes. At the focus is a system of one horizontal, and ele
vertical, spider-lines, together with a micrometer thread mov
in declination only. The mean equatorial interval of the vert
threads is 14ˢ·167.

The axis, thirty inches in length, terminates in steel pivots
inches in diameter, and to opposite faces of its central cube
bolted the two conical frusta forming the tube of the
scope. This tube is so constructed at the ends that the obj
glass and eye-tube are readily interchangable. On the axis, wi
the piers, are two circles forty inches in diameter. They
graduated on silver, the one to read by a vernier to single minu
the other by six micrometer microscopes, to single seconds. F
of the microscopes are mounted at the corners, and two at in
mediate points on the opposite sides, of a square alidade fra
which is carried by the axis, and held in position by adjus
screws connected with the pier. Attached also to the alidade
spirit level. Suitable counterpoises prevent undue pressure of
pivots on the Y's. For finding the nadir point, and the level

collimation errors, a collimating eye-piece and vessel of mercury are used. There is also a striding level for the axis; an observing couch; and a reversing apparatus traversing the floor on rails between the piers.

This instrument, as originally constructed by Ertel & Sons, of Munich, had a thirty-inch circle at each extremity of the axis, outside of the piers. These were subsequently replaced by the present forty-inch circles on the axis inside of the piers, by Wm. J. Young, of Philadelphia, who made also other minor alterations.

In the first and second volumes of the Washington Observations, this circle, in its original form, is fully described, and illustrated by plates. It has been put in adjustment, but not yet sufficiently used to test its performance.

The circle-room has a meridional opening from side to side, twenty inches in width, with roof-shutters, which are opened or shut by a single motion of a lever. The side shutters are ordinary doors.

A Sidereal Clock, by Appleton, London, the gift of William Hillhouse, Esq., of New Haven, is attached to the west wall.

The room is reached either by a spiral staircase from the ground, as shown in the engravings, or from the roof of the building, across which is a walk connecting the two towers, and guarded by an iron railing.

The observatory possesses also a Pistor & Martins Patent Sextant. The private instruments referred to as used by students in Practical Astronomy are: a superior portable Telescope, by Clark & Sons, of $4\frac{3}{4}$ inches aperture and five feet focal length; a Transit Instrument with three-foot telescope, and twelve-inch circle reading by two verniers to 10″; a Sidereal Clock and an Eight-day Sidereal Chronometer. The telescope of the transit instrument has an object-glass, by Fitz, of $2\frac{5}{8}$ inches aperture, and a micrometer, so constructed as to be used with equal facility at all angles of position, without danger of disturbing the fixed system of threads. With this micrometer, and the spirit-level attached to the alidade of the circle, this instrument is practically a Zenith Telescope, and is used as such in observations for latitude by Talcott's method. The eye-piece constantly used is a diagonal one giving a power of 200, a power warranted by the excellence of the object-glass. The instrument is mounted on a heavy iron stand, cast in one piece, which is supported by a brick pier, four

feet in height, with its foundation of masonry extending several feet below the surface of the ground.

VII. Apparatus and Collections.

The apparatus and collections of the school have never been fully described, and therefore, in recording the additions of the current year, the Instructors present an extended statement of their means of illustration and experiment, inclusive of some of the private and the general collections.

A.—MINING AND METALLURGICAL MUSEUM.

[In charge of Professor BRUSH.]

The object of this Museum, deposited in Sheffield Hall, is to show the characters and mode of occurrence of all useful minerals, and to illustrate the various methods of preparation and extraction which are employed to render them of service in the industrial arts. It contains:

1. Suites of veinstones from noted mining districts, illustrative of the occurrence of ores and the character of the associated minerals.

2. A systematic collection of ores intended to show, in as complete a manner as possible, the physical characters of the various ores of the useful metals.

3. Such non-metallic minerals as are of economic importance, including salt, gypsum, emery, graphite, barytes, sulphur, cryolite, kaolin, etc.

4. A collection of rocks and building-stones, clays, limes, cements, etc.

5. A collection of the varieties of fossil fuel, including anthracite, bituminous, cannel, and brown coal, lignite, and peat.

6. Collections illustrative of the dressing or mechanical preparation of ores.

7. Specimens illustrative of the more important metallurgical processes employed in this country and in Europe, showing the successive steps by which the several metals are extracted from their native combinations, commencing with the raw ore, and passing through the various intermediary products to the marketable metal.

8. A collection of crystallized slags and furnace products.

9. A large collection of models and diagrams illustrative of mines and smelting works, and of mining and metallurgical apparatus.

The whole numbers several thousand specimens, and through the intelligent liberality of friends of practical science, the number and value of the collections are constantly increasing.

Among the European specimens are a collection of veinstones from the celebrated mining district of Freiberg, in Saxony, with suites of specimens illustrative of the European amalgamation process, the silver and lead smelting process, and the copper and silver extraction process used at the Freiberg metallurgical works. From the silver district of the Hartz mountains are suites illustrative of the metallurgical treatment of the ores of the Rammelsberg mine, and the mines of Andreasberg, Clausthal, and Lautenthal. From England and Wales are collections showing the methods of treatment of iron, copper, lead, and tin ores, the manufacture of tin-plate, etc.

Among the American collections are specimens from most of the important mineral districts in the country, and, as far as possible, suites to illustrate the occurrence of the ores of different metals, with the methods employed for their metallurgical treatment.

The more important recent donations to the Museum are ores from the gold and silver mining districts of California, Nevada, Arizona, and Idaho, received chiefly through Prof. Silliman, J. C. Clayton, Esq., of California, E. S. T. Arnold, Esq., of New York, H. R. Mighles, of Nevada, J. C. Clarke, Esq., of Oregon, and W. D. Walbridge. Esq., of Idaho;—Lake Superior copper and silver from Messrs. T. Henry Mason and Chas. J. Sheffield;—iron ores, from the Lake Champlain district, from Prof. Verrill;—Salisbury iron ores, from Mr. Chas. S. Rodman;—Pennsylvania iron ores, from Mr. J. H. Grove;—Wisconsin lead ores, from Dr. Peter Collier;—Wisconsin zinc ores, from Fred'k Moeller, Esq.; nickel ores, from Joseph Wharton, Esq.;—Nova Scotia and New Brunswick manganese ores, from Messrs. Fearing, Hobbs & Co., of Boston, and Mr. Barnes, C.E., of Halifax;—New Brunswick antimony ores, from Prof. Bailey;—California and Mexican tin ores, from Prof. Silliman. As illustrating metallurgical processes, have been added specimens of steel from the steel works of Messrs. Park Bros., Pittsburgh; from the Collinsville Co.; from Messrs. Winslow, Griswold & Holley's Bessemer steel works at Troy, N. Y.; and from E. Savage, Esq., of Meriden; specimens of iron from the Bethlehem iron works, from the Columbia works, and others;—lead specimens from the Mineral Point works;—specimens showing

Kent's modified Freiberg process for the treatment of gold and silver ores, from E. N. Kent, Esq., of New York; specimens of gold and silver from the *patio* process, from W. H. Hayden, Esq., of Honduras, etc. etc.

Mineral Cabinet.

The private mineral collection of Prof. Brush is also deposited in Sheffield Hall. This cabinet, consisting of some five thousand specimens, has been collected during the past twenty years, for the special purpose of illustrating the characters of the various mineral species and varieties as fully as possible. It is one of the most valuable and complete collections in the country, and is liberally used for the purposes of instruction in Mineralogy.

B.—MINERALOGICAL AND GEOLOGICAL MUSEUM.

[In charge of Professors Dana, Brush, and Marsh.]

The College Cabinet, deposited in the Cabinet building, on the college square, is well known as one of the most extensive geological and mineralogical collections in the country. It includes the choice collection of minerals bought of Col. George Gibbs in 1825, for $20,000, that purchased of Baron Lederer, Austrian Consul in New York, and other important purchases and donations brought together during the last half-century. The fossils number many thousands, from all formations, and are arranged according to their geological succession. The minerals are likewise systematically arranged according to Dana's Mineralogy. The College possesses other important collections in these departments, not yet arranged for exhibition.

A fine collection of about fifty slabs of fossil Footprints from the Connecticut River Sandstone at Turner's Falls, Mass., has recently been purchased for the Museum by the Corporation of Yale College. This collection was made by Mr. T. M. Stoughton, of Gill, Mass., and contains many specimens of great interest. The expense of transporting this large collection from Greenfield to New Haven was generously defrayed by the Conn. River, and New Haven, Hartford, and Springfield Rail Road Companies; and his honor, Mayor Sperry, of New Haven, has kindly allowed a room in the State House to be used for its temporary accommodation.

Mr. Roswell Field's valuable collection of fossil Footprints, also from the Connecticut River Sandstone of Turner's Falls, and two

smaller collections, containing many rare and some unique specimens, from the same locality, have more recently been purchased for the Museum with the first income of the Peabody Fund.

A large collection of fossil Vertebrates from the "Mauvaises Terres," or "Bad Lands," of the Upper Missouri region, collected during the past summer by Dr. F. V. Hayden, has quite recently been secured for the Cabinet, also with the income of the Peabody Fund. This collection contains many rare and valuable specimens, and among them probably the finest suite of fossil Turtles yet discovered in America.

An extensive collection of fossils and rocks from various parts of Europe, and many specimens from American localities, have been given to the Museum by Prof. O. C. Marsh. Donations have also been received during the past year from Mr. John DeLaski, West Falmouth, Me.; Mr. W. J. Beal, Union Springs, N. Y.; N. S. Shaler, Cambridge, Mass.; Mr. H. R. Mighles, Carson City, Nevada; Mrs. T. Clapham; Mr. Austin DeWolf, Greenfield, Mass.; Mr. F. H. Bradley, New Haven; and Mr. H. A. Green, Mt. Morris, N. Y.

Among the donations to the Geological Cabinet, previous to the present year, of which no official public acknowledgment has hitherto been made, the following deserve especial mention:

Richard S. Fellowes, Esq., of New Haven, a graduate of the class of 1832, generously defrayed the expenses of Mr. F. H. Bradley while on a collecting tour through New York State during the summer of 1864. By this donation of five hundred dollars, 16,200 specimens of fossils were added to the Cabinet.

In the following year, George J. Pumpelly, Esq., of Oswego, N. Y., a graduate of the class of 1826, made another donation of the same amount, and thus enabled Mr. Bradley, in company with Dr. P. Collier, and Mr. G. B. Pumpelly, to visit the States farther west, where they collected 10,200 specimens of Palæozoic fossils.

Prof. J. D. Dana also made a liberal contribution to the Cabinet fund in the same year, by means of which 6,850 specimens of fossils, mostly from New York State, were collected by Mr. Bradley. The expense of transporting these extensive collections to New Haven was generously borne by the Adams, American, and United States Express Companies.

Dr. W. A. Clapp, of New Albany, Ind., presented to the Museum in 1864 a valuable collection of 2,500 specimens of fossil Corals, *mostly from the Falls of the Ohio.*

The Smithsonian Institution in 1865 gave a fine collection of Cretaceous fossils from the United States, and various fossils collected by the Exploring Expedition under Capt. Wilkes.

Prof. B. Silliman presented to the Museum in the same year a very valuable collection of fossils, gold and silver ores, rocks, and furnace products from California. Prof. A. E. Verrill gave a collection of 1,611 specimens of fossils and rocks, chiefly from Nova Scotia, Maine, and New York; Prof. S. W. Johnson, 256 specimens of fossils and rocks from Northern New York; and Prof. G. J. Brush, 72 specimens of fossils, mostly from Western New York. Other individuals connected with the college have also made valuable donations to the Cabinet.

Walter S. Church, Esq., of New York, gave some interesting fossils, and some rare silver and copper ores from the Andes of Peru; T. W. T. Curtis, Esq. of Hartford, Ct., a collection of 420 specimens of fossils from Spergen Hill, Ind.; Dr. Thomas H. Totten, of New Haven, 13 specimens of fossils from Aspinwall; O. W. Corey, Esq., of Ind., 150 specimens of fossils from Crawfordsville, in that State; Messrs. W. W. Borden and D. I. Place, of New Providence, Ind., 400 specimens of fossils; Dr. W. W. Dawson, Cincinnati, Ohio, 100 specimens of fossils from Hillsboro, Ohio. The Cabinet has also been considerably increased of late through additions obtained by purchase and exchange.

In view of the rapid enlargement of this department of the Museum, it is very desirable that the entire collection should be rearranged, and systematically catalogued. This work has already been commenced, under the direction of the Professor of Palæontology, by Mr. W. H. Niles, Mr. W. N. Rice, and Mr. E. T. Nelson, students in this department, and will be continued until completed.

C.—COLLECTIONS IN ZOOLOGY.

[In charge of Professors DANA and VERRILL.]

Within the past two years, special attention has been given by Professor VERRILL to the increase of the College collections in Zoölogy, and to the preparation of the specimens for exhibition in the Peabody Museum, soon to be erected. Large accessions have been received from collectors more or less intimately connected with the School, from exchanges and gifts. Much labor has been bestowed upon the identification and labelling of specimens, and upon the preparation of systematic catalogues, in which

the entries correspond to the numbers affixed to both specimens and labels. Most of the Radiates and Crustaceans, and a large part of the shells, as well as portions of most of the other classes, altogether amounting to about 30,000 specimens, have been thus catalogued during the past year. In this work, Messrs. S. I. Smith, F. W. Stowell, W. S. Williams, and E. T. Nelson, students in the Zoölogical Department of the School, have rendered great assistance.

The regular excursions of the zoölogical classes of the School have added to the collection over 6,500 specimens, embracing nearly every order. A series of these, with other New England specimens, have been arranged, for the present, in the Agricultural lecture-room, for the purpose of illustrating the zoölogical lectures, as well as the geographical distribution of our New England species. A set of Insects injurious to vegetation has also been arranged in the same room.

A system of exchanges with other institutions, both American and foreign, has been established, which has already yielded valuable returns, and from which still more is expected in future.

The most important additions, however, are the collections made by Mr. F. H. Bradley, of the Scientific School, chiefly at Panama, Callao, and other points on the west coast of America. The expenses of this expedition have been paid by subscriptions from Prof. J. D. Dana, Prof. B. Silliman, John Cummings, Jr., Esq., of Boston, Hon. W. W. Boardman, of New Haven, Prof. G. J. Brush, Prof. S. W. Johnson, and C. S. Lynch, Esq., of Boston.

Acknowledgments are also due to David Hoadley, Esq., President of the Panama Railroad Co., and to F. W. G. Bellowes, Esq., Vice-President of the Pacific Mail Steamship Company, to whose liberality we owe the free transportation of these large collections, as well as free passages and other important facilities for Mr. Bradley.

From this source 38 barrels, boxes, and kegs, containing over 100,000 specimens, about one half of them preserved in alcohol, have been received.

The expenses of other collections received during the past year, as well as the general expenses attending their care and preservation (not including salary), have been paid from an appropriation of $500 from the funds of the Scientific School, and $150 from the College funds.

During the past two years the number of donations received was 229, including about 141,000 specimens. Three specimens were purchased; and 16 lots, containing 3,000 specimens, were obtained by exchange.

The following summary embraces the collections received during the past year, as well as those received the previous year, not before acknowledged. The number of specimens in some cases can, at present, be given only approximately.

ADDITIONS TO THE ZOOLOGICAL COLLECTIONS.

	Specimens.
PANAMA EXPEDITION—*Collected by F. H. Bradley.*—Mammals, Birds, Reptiles, Fishes, Insects, and Marine Invertebrata, from Panama and Pearl Islands; Reptiles, Fishes, Corals, Shells, and other Marine Invertebrates, Aspinwall; Fishes, Shells, Crustacea, and Radiates, Callao, Peru; Fishes, Shells and Radiates, San Salvador,	100,000
Prof. J. D. Dana.—Shells from Michigan, collected by F. H. Bradley; Reptiles, Insects, Crustacea, Worms, Corals, and Echinoderms, American and foreign,	835
Chas. Wright (Class of 1835, Y. C.), Wethersfield, Ct.—Land Shells, Cuba; identified by Thos. Bland, Esq.,	1,423
S. I. Smith, Sheffield Scientific School.—Reptiles, Bird's Eggs, Shells, Insects, Norway, Me.; Shells, Insects, etc., New Haven and vicinity,	7,016
Essex Institute, Salem, Mass., in exchange.—Corals, East Indies; Sponges, Echinoderms, Mollusca, etc., American and foreign; Crustacea, Insects, etc., Massachusetts,	266
Smithsonian Institution.—Shells from U. S. Expl. Expedition, W. Indies, California, Mazatlan, Cape St. Lucas, England; Birds' Eggs, many Arctic species; Fishes, Crustacea, Corals, and Echinoderms, American and foreign,	4,200
Prof. D. C. Eaton.—Corals, Echinoderms, and Shells, Florida; Shells, Sandwich Is., etc.; Insects, Europe and America,	1,441
Prof. B. Silliman.—Insects, Shells, etc., California and Colorado; Corals, W. Indies; Echinoderms, Panama; Indian Relics, California; Insects, Connecticut,	753
Prof. G. J. Brush.—Corals and Insects,	4
Prof. O. C. Marsh.—Insects and Mammals,	10
Prof. A. E. Verrill.—Fishes and Marine Invertebrates, Bay of Fundy; Reptiles, Insects, Shells, etc., New England; Foreign Corals and Shells; Shells, Insects, etc., Lake Champlain,	11,124
Prof. W. D. Whitney.—Shells, Africa; Birds, U. States and S. America,	120
Walter S. Church, Esq., New York.—Bird-skins, Peru,	9
F. H. Bradley (S. S. S.).—Birds, Reptiles, Insects, Shells, Connecticut and Virginia; Radiates and Mollusca, Long I. Sound,	727
Boston Society of Natural History, in exchange.—Echinoderms and Corals, American and foreign,	242
Rev. E. C. Bolles, Portland, Me.—Land and fresh-water Shells, Maine,	220
O. N. Brooks, Esq., Faulkner's Island.—Eggs of the Roseate Tern,	50
Chicago Academy of Natural Sciences, in exchange.—Bird-skins and Eggs, U. States and Arctic America,	218
Mrs. Martha Cook, Cambridge, Mass.—Insects from Cambridge and New York,	4
Peter Collier, Ph.D. (1866, S. S. S.).—Insects, New Haven,	46
A. Daggett, Jr., New Haven.—Insects, New Haven; Shells, etc., foreign,	53
Insects and Crustaceans, Africa (deposited),	8
W. W. Denslow, Esq., New York.—Insects, Reptiles, Shells, etc., New York,	25
H. M. Dudley (S. S. School).—Insects, Reptiles, Shells, etc., Connecticut and N. Y.; Fish, Mass.,	80
In exchange.—Insects, Massachusetts,	75

	Specimens.
Mrs. Wooster Hotchkiss, New Haven.—Shells and Echinoderms, E. Indies and China,	666
Dr. Thos. H. Totten (Class of 1834), New Haven.—Corals, Sponges, Shells and Echinoderms, Aspinwall,	677
Mrs. Dr. W. Parker, New York.—Insects, etc., from S. Africa (deposited),	14
Reptile, S. Africa; Insects, Upper India (donated),	15
W. S. Brewer.—Egg of Peacock,	1
Wm. Stone (Class of 1865).—Reptiles, Insects, etc., New Haven; Insects and Reptiles, Croton Falls, N. Y.,	30
George J. Pumpelly, Esq., Oswego, N. Y. (Class of 1826).—Reptiles, Insects, Shells, etc., Indiana, Ill., and N. Y., collected by F. H. Bradley,	716
Wm. C. Minor, M. D., New Haven.—Insects, Shells, etc., Ceylon; Corals and Shells, Florida; Reptiles, Shells, etc., New Haven,	912
Skulls and Skeletons, Mammals, Birds, Fishes (deposited),	20
Alex. U. McAllister (Class of 1866, S. S. S.).—Insects, New Haven,	2
Prof. W. H. Brewer.—Shells from Germany; do. from Mississippi River; Reptiles, New York; Insects, New Haven,	139
Prof. A. E. Verrill and S. I. Smith.—Insects, Shells, Fishes, Crustacea, etc., Connecticut,	618
S. I. Smith and S. S. Ferry (S. S. S.).—Crustacea, Worms, Insects, Fishes, Connecticut,	45
Prof. A. E. Verrill and Zoölogical Class (Class 1866, S. S. S.).—From Zoölogical Excursions, Mammals, Birds, Reptiles, Fishes, Insects, and Marine Invertebrates,	2,079
Do. (Classes 1867 and '68, S. S. S.).—From Zoölogical Excursions, land and marine,	4,657
Prof. S. W. Johnson.—Insects from Grape-Vine; Potato Beetle, Iowa; Insects from Lewis Co., N. Y.,	44
E. Suffert, Esq., Cuba, in exchange.—Insects from Cuba,	128
Amos Shepherd, Esq., Plantsville.—Insects, Reptiles, etc., Bristol and Plantsville, Ct.,	249
L. Trouvelot, Esq., East Medford, Mass.—American and foreign Silk-worms and Silk, etc.,	10
T. G. Sanborn, Esq., Boston, Mass.—Insects,	31
A. S. Packard, Jr., M.D., Salem, Mass.—Insects from Maine and Mass.; Crustacea and Radiates from Maine,	27
Invertebrates from Labrador, (in exchange),	800
E. S. Morse, Esq., Salem, Mass.—Insects from Maine; Corals, foreign,	5
M. N. Chamberlain (Class of 1857).—Starfish, West Indies,	1
H. W. Green, Esq., Mt. Morris, N. Y.—Shells,	31
S. L. Chittenden (S. S. S.).—Living Puffing Adder, New Haven, Ct.,	1
C. A. DeKay (Class of 1868).—Insects from Germany,	178
George F. Barker, M.D. (Class of 1858, S. S. S.).—Centipedes, West Indies,	8
W. A. Copp (Class of 1869).—Fish, New Haven,	1
Geo. W. Peck, New York.—In exchange, Insects, U. States,	20
Horace Mann, Cambridge, Mass.—Echinoderms and Corals, Pacific Ocean,	44
C. R. Dodge (S. S. S.).—Shells and Insects, Washington, D. C.; Crustacea, Insects, Shells, Connecticut,	505
Forrest Shepherd, Esq. (Class of 1827), New Haven.—Fish and Shell, Newfoundland; Insects' eggs, Texas,	20
Prof. A. Van Name.—Insects, New Haven,	5
Prof. H. A. Newton.—Insects, New Haven,	2
J. W. Gibbs, Esq. (Class of 1858).—Insects, New Haven,	6
Prof. H. A. Newton and J. W. Gibbs.—Insects, New Haven,	10
C. W. Chase, North Adams, Mass.—Insect,	1
Jno. Spence, Esq., Milford, Ellis Co., Texas.—Living "Horned Toad," Texas,	1
Miss Ellen D. Eaton, New Haven.—Rare Insect,	1

	Specimens.
Richard E. Smyth (Class of 1866), Guilford.—Insects from Guilford, Ct., and Iowa,	58
John H. Grove (S. S. S.).—Insects, New Haven,	9
W. H. Niles (S. S. S.).—Insect, New Haven,	1
W. N. Rice (S. S. S.).—Bat and Insect, New Haven,	2
D. H. Wells (S. S. S.).—Insects, Long Island,	2
E. T. Nelson (S. S. S.).—Shells and Echinoderms, Long Island Sound, and Chelsea, Mass.,	164
F. W. Stowell (S. S. S.).—Echinoderms, California; Shells, Worms, Crustacea, Echinoderms, Long Island Sound,	204
H. S. Williams (S. S. S.).—Shells, etc., New Haven; do., Ithaca, N. Y.,	85
H. S. Manning (S. S. S. 1861.)—Corals from Tortugas, Florida,	26
W. J. Beals, Esq., Union Springs, N. Y.—Shells and Crustacea, Michigan and N. Y.,	609
J. H. Sternbergh, Esq., Panama.—Mammals, Reptiles, Insects (with nests), Chiriqui Pottery, etc., Panama and vicinity,	194
Miss Kate Sternbergh, Panama.—Insects and Scorpions,	26
Wm. H. Sternbergh, Panama.—Insects,	5
Don Pedro Brocals, San Miguel—Insects from Pearl Islands,	4
Dr. Marsh, U. S. N.—Large Locust, Panama,	1
Henry Edwards, Esq.—Starfishes, Crustacea, Shells, Hydroids, Sponges, etc., New Zealand; Sponges, Shells, Hydroids, New South Wales,	361
Museum of Comparative Zoology.—In exchange, Echinoderms, Acapulco, Mexico,	4
C. Cowles, Esq., New Haven.—Squilla, Long I. Sound,	1
Prof. A. E. Verrill.—Corals, E. Indies; Echini, miscellaneous, from Essex Institute; Corals, types of new species, Pacific Ocean (deposited),	205
F. W. Fellowes, Esq. (Class of 1853), New Haven.—Oysters from France,	2
Mrs. H. R. Mighels, Carson City, Nevada.—Shells from Nevada,	22
J. H. Slack, M.D., Philadelphia.—Casts of head and skull of Gorilla castaniceps Slack; and skull of Chæropsis Liberiensis Leidy,	3
Purchased.—Of J. G. Rich, Upton, Me., a Caribou, mounted; of F. W. Putnam, a Bird of Paradise, mounted; of a sailor, jaw of Shark, W. Indies,	3

SPECIMENS SENT AWAY IN EXCHANGE.

The following collections, numbering 2212 labelled specimens, have been sent out during the past year. Several other similar collections are nearly ready for sending.

Prof. C. E. Hamlin, Waterville, Me.—Shells from Long Island Sound,	159
Dr. A. S. Packard, Salem, Mass.—Crustacea, Echinoderms, and Shells, Long Island Sound,	40
Essex Institute, Salem, Mass.—Insects from Connecticut and Maine,	88
Minerals, various localities,	50
Echinoderms, New England; Corals and Echinoderms, Panama and Aspinwall,	54
Crustacea, Worms, and Mollusca, Long Island Sound,	314
Prof. S. Tenney, Vassar Female College, Poughkeepsie, N. Y.—Insects, New England,	500
Marine Invertebrata, New England and Labrador,	699
C. F. Hartt, New York.—Corals and Echinoderms, New England and foreign,	91
Boston Society of Natural History.—Echinoderms, Eastport, Me.,	10
Corals and Echinoderms, Panama, etc.,	45
Museum of Comparative Zoölogy.—Echinoderms, Eastport, Me., and Panama,	8
E. Suffert, Esq., Cuba.—Insects of New England,	150

Collection of Native Birds.

A beautiful collection of Native Birds has been placed in Sheffield Hall by Professor Whitney, who collected and arranged them. The glass case in which they are exhibited now stands in the second story of the East wing, at the head of the staircase leading to the Metallurgical Museum. This collection, numbering 152 specimens, includes examples of nearly all the birds which are ordinarily met with in Connecticut. Being neatly mounted and catalogued, they furnish to the students an excellent illustration of the local ornithology.

D.—COLLECTIONS IN BOTANY.

Professor Eaton's private library and herbarium are the principal accessories to the study of Botany, which are available for students. The herbarium contains the greater part of the known plants of the United States, and has been enriched with large collections from England, Germany, Norway, Japan, Australia, the Pacific Islands, Cuba, etc., so that it contains not less than eight or ten thousand species. The collection is well mounted and arranged according to the most improved methods, and it is increasing by large accessions every year.

Prof. Brewer's herbarium, which is kept in Sheffield Hall, is also accessible to students in Botany.

The Flora of the region about New Haven is rich and varied, and includes maritime as well as inland species in great abundance.

E.—AGRICULTURAL MUSEUM.

[In charge of Professors Brewer and Johnson.]

The Agricultural Lecture-room, recently completed, is furnished with commodious cases for specimens to illustrate Agricultural instruction. The space is not sufficient for the reception of bulky implements and machines, but is otherwise adequate to the present requirements of the School.

There is already in this collection a series of authentic guanos, superphosphates, and other commercial fertilizers, numbering 220 specimens, of which about 100 have been accurately analyzed by or under direction of Prof. Johnson; a series of peats and swamp mucks, 30 in number, also analyzed under direction of Prof. Johnson, in his capacity of Chemist to the State Agricul-

tural Society; 40 samples of soils, 180 specimens of minerals, and rocks illustrative of the origin of soils, etc. etc.

In addition, Prof. Verrill and Mr. S. I. Smith have arranged 5,000 specimens of insects injurious and useful in Agriculture.

The School is indebted to the following persons for important contributions:

John T. Andrew, Esq., West Cornwall, Conn., samples of Leicester and Cotswold Wool.

Prof. Chandler and A. A. Julien, of Columbia Coll., a suite of the rock guanos of Sombrero Island.

Prof. J. D. Hague, of the Mass. Institute of Technology, a suite of 40 specimens of Guano from Baker's, Jarvis, and other islands in the Pacific.

Prof. C. U. Shepard, of Amherst College, twelve samples of Carolina cotton and sugar soils, marl, &c.

G. N. Cleveland, of Mass., ten samples of green sand marl from New Jersey.

S. L. Goodale, Sec'y of the Maine Board of Agriculture, three samples of ground bone, four of superphosphate of lime, and six specimens of Borden's extract of beef.

T. S. Gold, Esq., Sec'y of the Conn. Board of Agriculture, six samples of South Down wool.

Samuel Fowler, Esq., of Westfield, Mass., 6 samples of Georgia cotton soils.

Dr. R. A. Fisher, of Grass Valley, Cal., box of specimens illustrating Dr. Von Welsbach's preparation of fibre, cloth, and paper made from the husks of Indian corn at the Imperial Austrian paper manufactory, near Vienna, and sample of many-headed wheat from Pike's Peak, Colorado.

Clarence King, Ph.B., late of the Geological Survey of Cal., specimen of Pine Sugar from the Sierra Nevada of Cal.

Messrs. F. F. Thomas and G. W. Mixter of the Scientific School, specimens of soils, 3 samples from Tioga Co., N. Y., and 2 from Rock Island, Ill.

Prof. B. Silliman, 7 samples of alkali soils from Nevada.

Rowland Hazard, Esq., Peacedale, R. I., specimens of dyed wool.

It is desirable to increase these collections, and friends of the School will confer a great favor by sending specimens of soils of remarkable or characteristic quality (in quantities of 4 quarts) of guano or other natural fertilizers and of new artificial fertilizers (in quantities of 2 quarts); seeds of useful plants, especially of new or rare varieties; textile fabrics, and vegetable products generally that admit of preservation; portraits and small models of thoroughbred animals; specimens of wool and animal fibres; small models of implements and machines; models or figures of fruits, roots, and perishable products. Parties willing to contribute to the Agricultural Museum will receive lists of desiderata and *other information* they may require, on application to Prof. Brewer

F.—ENGINEERING MODELS, INSTRUMENTS, AND APPARATUS.

[In charge of Professors NORTON and LYMAN.]

The Department of Engineering is provided, by the liberality of Joseph E. Sheffield, Esq., with a large collection of geometrical, architectural, topographical, and constructional models. The collection comprises a large number of models in plaster, made by M. Bardin, formerly Professor in the Polytechnic School in Paris, and sets of models in wood, made by Schröder in Darmstadt, and a considerable number contrived for special purposes of instruction, and made in New Haven.

The Department is also furnished with a full set of instruments for surveying and field engineering—compass, theodolite, level, transit, &c.—and with a suite of apparatus contrived by the Professor of Engineering for the purpose of testing the theoretical laws of the strength and stiffness of materials.

The following is a brief statement of the different sets of models in the collection:

I. *Models in Plaster.*

1. Geometrical Solids—including solids of revolution, helicoidal bodies, twisted rings, torus's, &c.
2. Poinsot's Regular Polyhedrons, with their derived forms.
3. Complete set of models, in illustration of the intersections of surfaces.
4. Set of models of arches, and their separate stones—oblique, groined, cloistered, terminated by curved surfaces, &c.
5. Spiral staircases.
6. Screws of different forms.
7. Models of bridges, with approaches and wing-walls.
8. Models of oblique bridges.
9. Models of niches.
10. Models of the Orders of Architecture; also, of twisted columns, and certain architectural details.
11. Two models of Capitals of Columns—new forms, designed and presented by Prof. Louis Bail.
12. Set of Topographical models, showing contour lines, shading, tinting, &c., with accompanying topographical drawings; and including a large model of the Pass of Mt. Cenis, showing contour lines, &c.

II. *Models in Wood, Iron, or Brass.*

13. Set of models in illustration of problems in Descriptive Geometry.
14. Set of Models of Joints.
15. Models of Warped Surfaces. A considerable number of these are in imitation of the Olivier Models, India-rubber threads being substituted for silk threads stretched by weights.
16. Large model of a Roof Truss of great span.
17. Model of McCallum's Arched Truss Bridge.
18. Models in Wood *and Metal, illustrating* the principles of mechanism.

III. *Working Models of Engines.*

Two highly finished models of Steam Engines—the one marine, the other oscillating (a working model)—both presented by T. S. Rowland, Esq., of the Continental Works, Greenpoint, L. I.

A fine working model of an Oscillating Engine, with boiler—presented by Wm. W. Woolsey, Esq., of New Haven.

A large sectional model of a Stationary Condensing Engine and Boiler, showing the arrangement and motion of the parts—brought to this country by Dr. Lardner, and used in his lectures.

G.—MAPS, CHARTS, AND TOPOGRAPHICAL MODELS.

[In charge of Professors NORTON and GILMAN.]

For illustrating the lectures in Physical Geography, and the other studies of the School, the beginning has been made of a collection of maps, charts, reliefs, and topographical models. As the scope of the School is extended, every thing which illustrates the physical structure of the globe, especially all maps, whether general or special, exhibiting the results of scientific surveys, will be found of use, not only in the instruction of classes, but for consultation and reference among scientific men. All such contributions to the resources of the School will be carefully preserved and exhibited.

For immediate service in the class-rôom, the below-mentioned means of illustration are now employed.

Guyot's Wall Maps, large series, illustrating the physical structure of the Earth and of the several continents.
Sydow's Wand-Atlas über alle Theile der Erde.
Ewald's Orographische Wand-Karte.
Berghaus and Stülpnagel's Wall Map of the Earth.
Bretschneider's Historische Wand-Karten von Europa.
General Atlases of Kiepert, Stieler, Berghaus, Sydow, etc.
Terrestrial and Celestial globes (16 inches).
Topographical model of the pass of Mt. Cenis.
Model of Mt. Blanc and its environs, by Kummer, 21×17 in. (from Ritter's library).
Relief-map of Switzerland, by Bauerkeller.
Relief-map of Palestine, by von Erbe. (13½×15½ inches.)
Relief-plan of Jerusalem, by Altmüller. (8×10½ inches.)
Van der Velde's new Wall Map of Palestine.
Series of Relief-plans of the environs of Metz, and a corresponding series of topographical maps illustrative of the different modes of representation and delineation.
Series of Relief-plans and Maps (similar to those just mentioned), representing the Isle de Porquerolles.

VII.—Public Lectures to Farmers.

The officers of the school refer with pleasure to their relations with the Connecticut State Board of Agriculture, organized by the General Assembly in the May session of 1866. By invitation of the faculty, the annual meetings of the Agricultural Board and of the State Agricultural Society were held in the large lecture-room of Sheffield Hall, on the 8th, 9th, and 10th of January, the lectures and discussions occupying both evening and day-time. By request of the Board, three public lectures were given by Prof. Brewer, one on "Irrigation in California," and two on "Diseases of Plants caused by Fungi." Prof. Johnson also gave a lecture on "Recent Investigations concerning the source and supply of Nitrogen to Plants," and a second on "The Principles which may guide the Farmer in the selection and use of Fertilizers."

Messrs. Brewer and Johnson having previously signified their willingness to devote some time to giving lectures on agricultural topics in different parts of the State, the Board of Agriculture, at their January meeting, accepted the offer, and directed that arrangements should be made for employing Prof. Brewer to lecture under their auspices during two weeks in the month of March. His services were to be gratuitously rendered, and the lectures were to be free; but the expenses of travel were to be borne by the Agricultural Board. In accordance with this arrangement, the appointments were made for Prof. Brewer in the following places:—Norwich, Central Village, Brooklyn, Stafford, Rockville, Hartford, Bristol, Norwalk, New Milford, and Falls Village.

VIII.—Public Lectures to Mechanics.

In continuance of the plan commenced last year, a series of evening lectures to Mechanics is now in progress in the large Lecture room of Sheffield Hall.

The object of this course is to gratify the interest of practical Mechanics, and others, in the discussion of scientific topics, and to diffuse a knowledge of scientific facts and principles.

The lectures are given on Monday and Thursday evenings, at a charge of one dollar for the course.

The Hall has been well filled by an intelligent and appreciative audience. The following is the programme:

I.	Jan. 28.	General considerations relating to Heat, - - - - - -	Prof. BARKER.
II.	" 31.	Dynamic Theory of Heat, -	" "
III.	Feb. 4.	Effects of Heat, - - - -	" "
IV.	" 7.	Meteorological Effects of Heat,	Prof. BREWER.
V.	" 11.	Warming and Ventilation, -	" "
VI.	" 14.	Fuel, - - - - - -	Prof. JOHNSON.
VII.	" 18.	" - - - - - - -	" "
VIII.	" 21.	Mechanical Relations of Heat,	Prof. LYMAN.
IX.	" 25.	" " " "	" "
X.	" 28.	Coal and Coal Mining,	Prof. ROCKWELL.
XI.	March 4.	" " " "	" "
XII.	" 7.	Copper, - - - - - -	Prof. BRUSH.
XIII.	" 11.	Zinc, - - - - - -	" "
XIV.	" 14.	Physical Geography of N. America,	Prof. GILMAN.
XV.	" 18.	" " " the U. States,	" "
XVI.	" 21.	Tides of the Atlantic Coast,	Prof. NORTON.
XVII.	" 25.	Magnetism and the Magnetic Needle,	" "
XVIII.	" 28.	Grecian Architecture, - -	Prof. BAIL.

IX. State Students.

The usual advertisements have been inserted in the newspapers of the State during the past year, announcing that a certain number of vacancies in the free scholarships of the School were open to applicants, preference being given to the sons of those who have fallen in the national army or navy, and, next to them, to young men in need of pecuniary assistance. Notwithstanding this publicity, the vacancies have not all been filled. The officers of the School believe that if the teachers in the various towns of the State should call attention to this opportunity for free scientific education, it might be of service to individual young men and to the State at large. It would be no pecuniary advantage to the School to have these scholarships filled; but we believe that the community would be greatly benefited by the education of more scholars in the various departments of scientific training.

Through a wise provision of the Legislature, the School is brought into advantageous relations with the State Board of Education, the Secretary of that body, like the former Superintendent of Common Schools, being an *ex officio* member of the Board of Visitors and of the Appointing Board. Rev. Birdsey G. Northrop,

the new incumbent of this office, early made himself acquainted with the scope of the School, and has expressed the intention of making known, as he moves about the State on his official tours, the opportunities which are here open for the scientific and practical education of young men. In this connection it may be proper to add, that the Faculty of the School stand ready at all times to show their interest in the promotion of the public school interests of the State. Professors Whitney, Brewer, and Gilman have delivered lectures at the Normal School within the year, and some of the Professors are under engagement to take part in the Teachers' Institutes.

X. Death of Professor John A. Porter.

Prof. JOHN A. PORTER, who was actively concerned in the administration of the School during a period of twelve years, died at his residence in New Haven, August 25, 1866. Although his official connection with this institution had been terminated in 1864 at his own request, in consequence of prolonged illness, his recent associates and colleagues desire in these pages to renew the testimony which was given last year respecting the unwavering interest which he maintained so long in this department of Yale College. A brief outline of his life may also be deemed appropriate.

John Addison Porter, son of Addison Porter, was born at Catskill, N. Y., March 15, 1822. During early life, his paternal home was Philadelphia. He graduated at Yale College in 1842, and continued his studies at home and in New Haven, until 1844, when he went to Newark, Del., to be connected with Delaware College, first as Tutor and then as Professor of Rhetoric. After remaining there three years, he went to Germany and studied Chemistry at Giessen under Dr. Justus Liebig. Returning in 1850, he soon became connected with Brown University, as Professor of Chemistry applied to the Arts. In 1852, he was invited to Yale College to succeed Prof John P. Norton as Professor of Analytical and Agricultural Chemistry, and he remained connected with the Scientific Department of this College (although his title and duties were altered as the institution became enlarged) until physical infirmities disabled him. He then went to Europe in the hope of improving his health—but his efforts were in vain, and after protracted sufferings, borne with Christian fortitude and submission, his life was ended at the age of forty-four.

Deeply interested in all departments of philosophical inquiry, possessed of a mind of unusual vigor, varied in his tastes and acquisitions, cultivated in the management of his pen and voice, he was for several years the principal exponent of the School before the public; and with marked enthusiasm and energy he devoted himself to the enlargement of the institution and its more thorough adaptation to the wants of the community. He also took a deep interest in political discussions, and was earnest in his efforts for the promotion of loyalty and charity during the recent war.

His published writings are but few in number, the chief of them being two elementary text-books on Chemistry, a pamphlet on Agricultural Schools, and occasional contributions to the periodicals of the day.

XI. Instructors and Studies.

The corps of instructors has been enlarged by the appointment of Othniel C. Marsh, Esq., a graduate of Yale College in 1860, to be Professor of Palæontology. Mr. Marsh was a scholar in this department from 1860 to 1862, and during the three years following resided abroad, chiefly at Berlin and Heidelberg, engaged in scientific studies. Since his return the instruction in geology has devolved on him, and the remainder of his time has been occupied in increasing the College collections in geology and palæontology.

Prof. Eaton, who was in Europe at the time of the last report, has returned home and resumed his instruction in Botany.

In accordance with the prospectus made public a year ago, the Mining and Metallurgical section has been organized as a distinct department of the School, and a class is now pursuing the special studies of this course under the instructions of Professors Brush and Rockwell.

Greater attention than heretofore has been bestowed upon the study of the English Language, though the time at command affords but limited opportunity for rhetorical criticism and practice.

The instructors are seriously considering whether a four years' course of study will not be more satisfactory than a three years' course.

The present arrangements may be gathered from the appended circular.

At the Commencement exercises of Yale College in 1866, five scholars of this department, having passed successfully the required examinations, were admitted by the President and Fellows to the degree of Bachelor of Philosophy, one to the degree of Arts, two to the degree of Civil Engineer, and one to the degree of Doctor of Philosophy. The graduating theses of these gentlemen, and the Berzelius and Silliman Prize Essays, were read before the President and Professors, and the friends of the graduating class, on Monday evening, July 23.

Instruction in Military Science has been given during the year, according to the requirements of the act of Congress, by Gen. A. von Steinwehr, an experienced Prussian officer, lately commanding a division of U. S. Volunteers.

The number of scholars in attendance during the academic year beginning September, 1866, has been 123,—of whom 14 have been Seniors, 32 Juniors, and 38 Freshmen, and the remainder have been students of partial or higher courses.

In conclusion, the Governing Board call the attention of the Visitors to the harmony subsisting between this institution and all the other organizations with which it is associated in the College and in the State. Friendly relations have likewise been maintained with the officers of other Schools of Science established in different portions of the country as a consequence of the national grant.

The friends of this department, both near and distant, are freely invited to become familiar with its practical work, and are assured that any contributions they can bestow upon its library, apparatus and collections, or its special and general funds, will be carefully directed to the advancement of the objects we have in view.

OFFICERS.

President,

Rev. THEODORE D. WOOLSEY, D.D., LL.D.

Professors,

WILLIAM A. NORTON, M.A.,	*Civil Engineering and Mathematics.*
JAMES D. DANA, LL.D.,	*Geology and Mineralogy.*
BENJAMIN SILLIMAN, M.D.,	*General Chemistry.*
Rev. CHESTER S. LYMAN, M.A.,	*Industrial Mechanics and Physics.*
WILLIAM D. WHITNEY, Ph.D.,	*Modern Languages.*
GEORGE J. BRUSH, M.A.,	*Mineralogy and Metallurgy.*
DANIEL C. GILMAN, M.A.,	*Physical Geography.*
SAMUEL W. JOHNSON, M.A.,	*Analytical and Agricultural Chemistry.*
WILLIAM H. BREWER, M.A.,	*Agriculture.*
ALFRED P. ROCKWELL, M.A.,	*Mining.*
DANIEL C. EATON, M.A.,	*Botany.*
OTHNIEL C. MARSH, M.A.,	*Palæontology.*
ADDISON E. VERRILL, B.S.,	*Zoölogy.*

Instructors,

MARK BAILEY, M.A.,	*Elocution.*
LOUIS BAIL,	*Drawing and Designing.*
JOHN AVERY, M.A.,	*Physics, etc.*
JAMES B. STONE, C.E.,	*Mathematics.*
BEVERLY S. BURTON, Ph.B.,	*Chemistry.*
CHARLES J. SHEFFIELD,	*Assaying.*

STUDENTS.

SENIORS.

Volney Giles Barbour,	*Bristol.*
John Kennedy Beeson,	*Uniontown, Pa.*
Alfred Caldwell,	*Wheeling, West Va.*
Samuel Hosmer Chittenden,	*Madison.*
Lyman Stewart Ferry,	*New Haven.*
Peter H Grove,	*Danville, Pa.*
Robert Michael Grove,	*Danville, Pa.*
Charles Henry Hubbard,	*Sandusky, O.*
William Gilbert Mixter,	*Rock Island, Ill.*
William Harmon Niles,	*Cambridge, Mass.*
Sidney Irving Smith,	*Norway, Me.*
Daniel Halsey Wells,	*Upper Aquebogue, N. Y.*
Joseph Thompson Whittelsey,	*New Haven.*
Luther Hodges Wood,	*West Haven.*

JUNIORS.

Wellington Miles Andrew,	*Orange.*
Leonard Strong Austin,	*Stratford.*
George Franklin Bailey,	*Rutland, Vt.*
Henry Norris Baker,	*Brooklyn, N. Y.*
Samuel Atkins Barbour,	*Bristol.*
Frederick Converse Beach,	*Stratford.*
James deTrafford Blackstone,	*Norwich.*
James Wood Chapman,	*Warsaw, N. Y.*
Albert Gardner Clark,	*Cincinnati, O.*
Henry Marchant Dudley,	*Whitinsville, Mass.*
Barton Darlington Evans,	*West Chester, Pa.*
Edward Forsyth Finney,	*St. Louis, Mo.*
James Fowler,	*Westfield, Mass.*
Joshua Comly Grove,	*Danville, Pa.*
Frank Morton Guthrie,	*Cincinnati, O.*
George Wesson Hawes,	*Worcester, Mass.*
John Corey Hersey,	*Bridgeport.*
Joseph Courten Hornblower,	*Paterson, N. J.*
George Anson Jackson,	*North Adams, Mass.*
Joseph Scott McKell,	*Chilicothe, O.*
Charles Kinney Needham,	*Louisville, Ky.*
Frederick George Noonan,	*Milwaukee, Wis.*
George Fowler Parmelee,	*New Haven.*
Lyman Bradley Parshall,	*Farmer Village, N. Y.*
William Wallace Redfield,	*Philadelphia, Pa.*
Alexander Renick,	*Chilicothe, O.*
Joseph Perkins Rockwell,	*Norwich.*
Lewis Bridge Stone,	*New York City.*
Samuel Swift,	*Brooklyn, N. Y.*
Charles Emory Tainter,	*Worcester, Mass.*
William Robert White,	*Philadelphia, Pa.*
Henry Shaler Williams,	*Ithaca, N. Y.*

FRESHMEN.

William Greene Abbot,	*Norwich.*
William Richardson Belknap,	*Louisville, Ky.*
Thomas Gray Bennett,	*New Haven.*
Roman Augustus Bissell,	*Detroit, Mich.*
Charles Augustus Brinley,	*Hartford.*
Eugene Stuart Bristol,	*New Haven.*
Francis Dudley Buck,	*New York.*
Charles Campbell,	*Millburn, N. J.*

Andrew Dwight Chidsey,	*New Haven.*
Clarence Marcellus Clarke,	*Fair Haven.*
Thomas Fassitt Collier, B.A. Wash'n Univ., St. Louis.	*St. Louis, Mo.*
Alfred Ronald Conkling,	*New York City.*
Frederick Smillie Curtis,	*Stratford.*
Charles Arthur Doten,	*Bridgeport.*
Augustus Jay DuBois,	*New Haven.*
Joseph Robinson Folsom,	*Fair Haven.*
Arthur De Wint Foote,	*Guilford.*
Julian Griggs,	*Chaplin.*
David Hanford,	*Middletown, N. Y.*
Albert Banks Hill,	*Redding.*
William Rufus Hopson,	*Bridgeport.*
Edward Whiting Johnson,	*Norwich.*
Joseph Goodhue Kendall,	*Cleveland, O.*
Charles Byron Koon,	*Auburn, N. Y.*
Augustus Washington Littleton,	*Peoria, Ill.*
Houston Lowe,	*Dayton, O.*
Wallace Ellingwood Mather,	*Andover, Mass.*
Henry Hoyt Perry,	*Southport.*
Charles Henrique Pope,	*Louisville, Ky.*
Walter Charles Riotte,	*San José, Costa Rica.*
Joseph John Skinner,	*Wallingford.*
Jay Wilson Smith,	*Lodi, Ill.*
George Frederic Stone,	*Hartford.*
Henry Herbert Swinburne,	*Newport, R. I.*
Robert Schuyler Van Rensselaer,	*Bordentown, N. J.*
Charles Alvah Weed,	*Binghamton, N. Y.*
Horace Franklin Whitman,	*Philadelphia, Pa.*
Willard Wendell Wight,	*Natick, Mass.*
Frederick Everett Willetts,	*Glen Cove, L. I.*

SPECIAL STUDENTS

PURSUING A HIGHER OR A PARTIAL COURSE.

John Thornton Baldwin,	*St. Louis, Mo.*
Frank Howe Bradley, B.A.	*New Haven.*
Stephen Henry Bronson,	*New Haven.*
Beverly Scott Burton, PH.B.	*Philadelphia, Pa.*
Nathaniel Burwash, B.A.	*Prof. Nat. Sci. Victoria Coll. C. W.*
Peter Collier, PH.D.	*Chittenango, N. Y.*
William Cook, B.A.	*New York City.*
John Morrison Davis,	*Allegheny City, Pa.*

Charles Richards Dodge,	*Washington, D. C.*
William Franklin Dow,	*Detroit, Mich.*
John H Grove,	*Danville, N. Y.*
Charles Frederick Hartt, B.A. Acadia Coll.	*St. John, N. B.*
Franklin Allen Hinds,	*Watertown, N. Y.*
William Knox,	*Philadelphia, Pa.*
Lewis Reed Lamport, PH.B. Univ. N. Y. City.	*New York City.*
George Richards Lyman,	*New Haven.*
Thomas Henry Mason,	*New York City.*
John James Matthias, PH.B.	*Newark, N. J.*
Edmund Hyram McIntyre,	*Middlesex, Vt.*
Frank Lawrence Miles,	*Elkhorn, Ind.*
Alexander Möller,	*Mineral Point, Wis.*
Wallace Mott,	*Roslyn, L. I.*
Edward Thomson Nelson, B.A. Ohio Wesl. Univ.	*Gallion, O.*
John Alsop Paine, M.A. Ham.	*Newark, N. J.*
Alexander Smith Palmer, PH.B.	*Stonington.*
Julius Hayden Pardee,	*Oswego, N. Y.*
George Brinckerhoff Pumpelly,	*Owego, N. Y.*
William North Rice, B.A. Wesl. Univ.	*Springfield, Mass.*
Charles Shepard Rodman,	*New Haven.*
Charles Joseph Sheffield,	*New Haven.*
James Bennett Stone, C.E.	*Boonton, N. J.*
William Stone, B.A.	*Croton Falls, N. Y.*
Franklin Wallace Stowell,	*Brooklyn, N. Y.*
Frederic Terry,	*New Haven.*
Clarence Hawkins Upton,	*Rochester, N. Y.*
Sereno Watson, M.A.	*Hartford.*
William Clarke White,	*Rochester, N. Y.*
Gardiner Howland Wolcott,	*Astoria, N. Y.*

Seniors,	14
Juniors,	32
Freshmen,	39
Special Students,	38
Total,	123

PROGRAMME.

Object.

The object of the Sheffield Scientific School is to provide young men with instruction in the various departments of Mathematical, Physical and Natural Science. By an act of the Legislature it has been constituted the Connecticut college for the promotion of Agriculture and the Mechanic Arts, and has received the benefit of the land appropriation bestowed by Congress upon this commonwealth. As a department of Yale College it shares in the advantages which pertain to that long established seat of learning. Private generosity has provided additional facilities for the prosecution of scientific studies.

Organization.

The care of the institution is entrusted, under the President and Fellows of Yale College, to a Governing Board of thirteen professors, who are also the instructors of the school, each of them representing some department of learning. Seven other teachers are also employed.

The classes of the school are arranged in seven sections, as follows:

I. Chemistry and Mineralogy.
II. Civil Engineering.
III. Mechanics.
IV. Mining and Metallurgy.
V. Agriculture.
VI. Natural History and Geology.
VII. Select Course in Science and Literature.

The arrangements of all these sections are fully exhibited below.

Building and Apparatus.

Sheffield Hall, in which most of the instruction is given, is a large and well arranged building containing recitation and lecture rooms for all the departments of the school, a hall for public assemblies and lectures, a drawing room for the engineering class, laboratories for chemical and metallurgical investigations, a photographical room, an astronomical observatory, a museum, a library *and reading* room, besides studies for

some of the professors, where their private technical libraries and collections are kept.

The various collections of the School and of the College (so far as the latter are applicable to this department) have been described in the foregoing report.

Regular and Partial Students.

The pupils of the scientific school are thus classified: *first*, those who are pursuing a systematic and prescribed course of study, extending through three years, and leading to the degree of Bachelor of Philosophy; *second*, those who have already been admitted to the degree of Bachelor of Philosophy, Science, or Arts, and are pursuing an advanced course of study leading to the degree of Doctor of Philosophy, or in some cases to the degree of Civil Engineer; and *third*, special students, who have already made a certain degree of proficiency in some department of science, and are now pursuing special scientific studies under the personal direction of some of the professors.

Degrees.

The degrees below named are conferred by the Corporation of Yale College on students who have passed the required examinations at the close of their course, and are recommended as candidates by the Governing Board of the School:—

1. Bachelor of Philosophy, conferred at the termination of three years' study in any one of the several sections of the School;

2. Doctor of Philosophy, conferred on those who have already been admitted to the degree of Bachelor in Philosophy, Science, or Arts (in this or in any other college), and who have successfully pursued in this college a higher course of study,—when the Baccalaureate degree does not indicate an acquaintance with the Latin and Greek languages, the candidate being required to show some proficiency in these studies;

3. Civil Engineer, conferred on students of the engineering section who have already taken the degree of Ph.B., and subsequently pursue with success the higher course of engineering.

In addition to the diploma of the Corporation, the instructors will give a formal certificate stating how long the student has been a member of the institution and in what department of study he is proficient. This certificate will be awarded only to meritorious students, after a thorough examination, and will be considered as the personal recommendation of the professors who sign it.

Conditions of Admission.

All applicants for admission must be not less than sixteen years of age, and must bring satisfactory testimonials of good character. Students intending to enter on the higher and special courses of study must exhibit satisfactory evidence of their fitness to take up the branches they propose to pursue.

Students desiring to go through any one of the prescribed three-year courses of the school, as candidates for the degree of Bachelor of Philosophy, must sustain an examination in the following books, or their equivalents:

Algebra—Davies, as far as General Theory of Equations. *Geometry*—Davies's Legendre.* *Plane Trigonometry*, including Analytical Trigonometry—Loomis or Davies. *The Elements of Natural Philosophy*—Loomis or Olmsted. *Arithmetic*, (including, after 1867, the Metric system of weights and measures.) *English Grammar, Geography, and the History of the United States.*

Some acquaintance with the Latin language is regarded as essential to the most efficient progress in the studies of the school, and accordingly it will soon be made a subject for the preliminary examination. All who desire it can so readily secure instruction in this tongue that none should neglect to secure the advantages which come from its study. In the French and German classes great assistance will be derived from previous training in Latin,—while but little will be gained by the preliminary study of French and German, as every class at present begins with the rudiments of these languages. Latin is also indispensable to the advanced students of Zoölogy and Botany, and is of value in the nomenclature of all departments of science.

In consequence of the incomplete preparation of many of the candidates, it is proper to say that the examination for admission is strict and full. As the studies above named are not pursued in the school, and are essential to successful progress, no one can be received as a scholar who is not well acquainted with these branches.

Candidates for advanced standing are examined, in addition to the preparatory studies, in those already pursued by the class they propose to enter. Any person admitted to an advanced standing, unless coming from another college, pays the sum of ten dollars as tuition money for each term which has been completed by the class which he enters. No one can be admitted as a candidate for a degree after the commencement of the last year of the course.

* Playfair's Euclid is *not* accepted as an equivalent.

Time of Admission.

The regular examinations for admission to the Scientific School take place at Sheffield Hall, on the Tuesday preceding "Commencement," at 9 o'clock, A. M., and eight weeks later, on that Wednesday in September on which the fall term begins—that is, in 1867, July 16, and Sept. 11. Opportunity for private examination may, in exceptional cases, be given at other times.

Terms and Vacations.

The public Commencement is held on the last Thursday but one in July of each year. The first term begins eight weeks from the day before Commencement and continues fourteen weeks; the second begins on the first Wednesday in January and continues fourteen weeks; the third, of twelve weeks, begins, this Collegiate year, on the last Wednesday in April and continues till Commencement. The intervening periods, of eight, two, and two weeks are assigned for vacations.

The graduating exercises of the Scientific School take place on the Monday (July 15, 1867) before the Public Commencement.

Tuition.

The charge for tuition is $100 per year, payable $35 at the beginning of the first and of the second term, and $30 at the beginning of the third term. The special student of Chemistry will be at the additional charge of seventy-five dollars per annum for chemicals, and for use of apparatus. He will also supply himself at his own expense with gas, flasks, crucibles, &c., the cost of which should not exceed five or ten dollars per term.

The fee for graduation as Bachelor of Philosophy is five dollars.

Lectures.

Annual courses of lectures are given on the following topics:

FIRST TERM.

On Metallurgy, by Prof. BRUSH.
On Mining, by Prof. ROCKWELL.
On Practical Agriculture, by Prof. BREWER.
On Agricultural Chemistry and Physiology, by Prof. JOHNSON.
On the History of Language and Linguistic Ethnology, by Prof. WHITNEY.
On Entomology, by Prof. VERRILL.

SECOND TERM.

On the Strength of Materials, by Prof. NORTON.
On Metallurgy (continued), by Prof. BRUSH.
On Mining (continued), by Prof. ROCKWELL.
On Practical Agriculture (continued), by Prof. BREWER.
On Agricultural Chemistry and Physiology (continued), by Prof. JOHNSON.

On Botany, by Prof. EATON.
On Structural and Systematic Zoölogy, by Prof. VERRILL.
On the History of Language and Linguistic Ethnology (continued), by Prof. WHITNEY.
On Physical Geography, by Prof. GILMAN.
On Military Science and Tactics, by Gen. A. VON STEINWEHR.
On the Principles of Mechanism, by Prof. LYMAN.

THIRD TERM.

On Mineralogy, by Prof. BRUSH.
On Rural Economy and Farm Management, by Prof. BREWER.
On Structural and Systematic Zoölogy (continued), by Prof. VERRILL.
On the Steam Engine, by Prof. LYMAN.

Examinations.

Oral examinations are held at the close of every term on the studies of the term, and written examinations are held every year on the studies of the year.

COURSES OF STUDY.

All who are candidates for the degree of Bachelor of Philosophy are expected to pass through the same course of instruction in the first year of their connection with the institution, unless they are admitted on examination to an advanced standing. The studies of Freshman year are those which are regarded as an important basis for all the higher instructions of the school. This introductory course includes a continuance of the mathematical studies required for admission, the general elements of Chemistry and Physics, the commencement of German, practice in English composition and Elocution, Surveying, and Drawing, —as will be seen more fully in the following outline. Near the close of Freshman year, every student is required to announce his selection of one of the seven higher courses of study,—and he is not allowed to change after the beginning of the second or Junior year without permission specially granted by the Governing Board.

Freshman Year.

INTRODUCTORY TO ALL THE SECTIONS OF THE SCHOOL.

FIRST TERM.

Mathematics—Davies's Analytical Geometry. Spherical Trigonometry. Surveying. *Physics*—Silliman's Principles. *English Language*—Exercises in Composition. *Chemistry*—Recitations and Lectures. *German*—Woodbury's Method and Reader.

SECOND TERM.

English--Rhetoric. Practical Exercises in Elocution. *German*--Woodbury continued. Selections from approved authors. *Physics*—Silliman's Principles, and Academical Lectures. *Chemistry*—Recitations and Lectures. *Mathematics*—Descriptive Geometry and Geometrical Drawing.

THIRD TERM.

English—Exercises in Composition. *German*—Selections. *Physics*—Silliman's Principles, and Academical Lectures. *Chemistry*. *Mathematics*—Principles of Perspective. *Botany*—Gray's Manual. *Drawing*—Free Hand practice.

Junior and Senior Years.

During the last two years of the course the students are instructed in separate sections, the particular arrangements of which may be found below. Each section is under the charge of special professors, with the exception of the Select Course, which is under the general charge of the Governing Board. To a considerable extent the students of the several sections recite together. The study of French is commenced in the Junior year, and is required of all the students.

I. CHEMISTRY AND MINERALOGY.

[Under the direction of Professors JOHNSON and BRUSH; Chemical Laboratory, Sheffield Hall, West Wing.]

The Sheffield Laboratory is fitted up in a complete and convenient manner, is provided with all the requisite apparatus and instruments of research, possesses a considerable collection of chemical preparations, and a consulting Library of the best treatises on Chemistry and the Chemical arts. It affords facilities for instruction in the various branches of theoretical and practical Chemistry.

Theoretical and Descriptive Chemistry are taught throughout the whole of the Junior year by lectures and by recitation,—Eliot and Storer's Manual and Miller's Elements being employed as text-books. The lectures of Professor Silliman to the Academical and Medical Classes are also accessible to the Senior students. Every autumn term a class recites from Fresenius's Qualitative Analysis. Extended courses of Lectures on Agricultural and Metallurgical Chemistry are given yearly.

Mineralogy is taught in the Junior Year by lectures, which are fully illustrated with hand specimens and models, and by weekly exercises throughout the Senior Year in the identification of minerals from physical and chemical characters.

The Laboratory is open for Chemical Practice seven hours daily, except on Saturday, when it is closed in the afternoon. The student repeats a large number of experiments from Eliot and Storer's Manual, and works through a course of qualitative and quantitative analysis, which is varied according to his capacity and the object he has in view. Each pupil proceeds by himself independently of the others, under the constant guidance of the Instructors.

In connection with the department of Mining and Metallurgy, especial attention is given to assaying and the investigation of ores and furnace products. The student in Agriculture has opportunity to acquaint himself with the modes of research employed in agricultural chemistry. The applications of the science to other branches of industry are taught as occasion requires.

The systematic course likewise includes instruction in Zoölogy, Botany, Geology, and the French and German languages, as will be seen from the following programme:

Freshman Year (see page 51).

Junior Year.

Inorganic Chemistry—Eliot & Storer's Manual, Recitations and Lectures. *Analytical Chemistry*—Fresenius. Recitations and Lectures. *Laboratory Practice*—Repetition of Experiments from Eliot & Storer's Manual. Systematic Qualitative Analysis. Use of the Blowpipe. Quantitative Analysis. *Mineralogy*—Dana's System, Lectures and Practical Exercises. *Botany*—Gray's Manual, Excursions and Preparation of Herbarium. *Zoölogy*—Lectures and Excursions. *French and German* (see Select Course).

Senior Year.

General Chemistry—Academical and Medical Lectures. *Agricultural Chemistry and Physiology*—Lectures. *Laboratory Practice*—Quantitative Mineral Analysis. Assaying. Organic Analysis. Special Investigations for Graduating Thesis. *Mineralogy*—Identification of Species. *Metallurgy*—Lectures. *Geology*—Dana's Manual. Recitations and Academical Lectures. *Human Anatomy and Physiology*—Academical Lectures. *Mechanics, Steam Engine, and other Prime Motors*—Lectures. *French* (see Select Course).

To advanced students, whether belonging to the regular classes or not, who desire to give attention to particular branches of chemistry, or to pursue original investigations, every facility is accorded.

The private libraries of the professors, containing the chemical journals and the recent foreign literature of chemistry and mineralogy, the large collections of ores, furnace products, &c., belonging to the School, and the extensive private cabinet of the Professor of Mineralogy, are freely used as aids in *instruction.*

II. CIVIL ENGINEERING.

[Under the direction of Professor NORTON.]

The special course in Civil Engineering comprises theoretical and practical studies, and exercises in field operations and in drawing. It is designed, in connection with the studies of the first year, to secure, at the same time, the thorough mathematical training and general scientific knowledge essential to success in the profession of Engineering; and it accordingly includes the careful study of the applications of Mathematics, Mechanics, Physics, Chemistry, &c., to Engineering, the use of Surveying and Engineering Instruments, and an extended course of practice in Field operations and in Drawing. The student is also enabled to acquire a sufficient knowledge of French and German to make himself acquainted with professional works published in these languages.

The following is the programme of the course of study:

Freshman Year (see page 51).

Junior Year.

Mathematics—Descriptive Geometry, with applications. Shades, Shadows, and Linear Perspective. Analytical Geometry of three dimensions. Differential and Integral Calculus. *Astronomy*—Theoretical Astronomy. Practical Problems. *French* and *German*. *Practical Surveying*—Triangulation, Surveying of a Harbor, &c. Topographical Surveying. *Drawing*—Isometrical, Topographical, Mechanical.

Senior Year.

Mechanics—Theoretical Mechanics. Applications of Calculus to Mechanics. Mechanics applied to Engineering. Principles of Mechanism. Thermodynamics. Theory of Steam Engine. Prime Movers. *Civil Engineering*—Strength and Stiffness of Materials. Bridge Construction. Stability of Arches. Stone-cutting, with graphical problems. Constitution and properties of Building Materials. Civil Engineering proper, or the Science of Construction. *Geology*. *French*—Selections. *Field Engineering and Surveying*—Location of Roads. Laying out Curves. Geodesy. *Designing*—Designing of Bridges, and other Structures. *Drawing*—Architectural and Structural.

The Department is furnished with a full set of instruments for Surveying and Field Engineering, and with a large collection of illustrative models.

HIGHER COURSE OF ENGINEERING.—The student in this department who on the completion of the three years' course has taken the degree of Bachelor of Philosophy, has the opportunity of pursuing a higher course, designed to give a special training, preparatory to professional

practice. This includes, together with higher theoretical studies, Practical Astronomy, with exercises in astronomical observations with the Transit Instrument, Meridian Circle, Zenith Telescope, and Sextant; and a course of exercises in the designing of structures. At the completion of this higher course the degree of Civil Engineer is conferred upon examination, and upon sufficient evidence being given of the ability of the student to design important structures, and make the requisite drawings, calculations, and estimates.

III. MECHANICAL ENGINEERING.

[Under the direction of Professor LYMAN.]

This section is closely connected with that of Civil Engineering, and many of the studies embraced in it are common to both. Prominence is necessarily given to the Mathematics and their applications, and to Mechanical Drawing, as lying, the one at the foundation of all thorough theoretical training, the other, at that of professional practice. With these are joined other branches of science, and modern languages, in order to secure both mental discipline and a better mastery of the special studies of the course.

The main object of the course is, by training the student in "such branches of learning as are related to the mechanic arts," to qualify him, as a mechanical engineer, for contributing towards the more efficient prosecution of these arts his services in the superintendence, construction, designing, or invention of machinery, in the management of mills or other mechanical works, or in the many other ways that lie within the scope of his profession.

It is not, of course, to be expected that the student will leave the institution with a full practical knowledge of the details of his professional work. The inculcation of the principles is the leading object. And yet, it is intended to bring the theory into as close relations with practice, as circumstances, and the time allotted to the course, will allow. To this end, practice in the use of tools is secured, for students needing it, in first-class machine shops in the city, to such extent as may be required. There is, as yet, for want of the necessary means, no shop for mechanical practice connected with the School.

PROGRAMME OF STUDIES.

Freshman Year (see page 51).

Junior Year.

French and German (see Select Course). Descriptive Geometry with Applications. Analytical Geometry of Three Dimensions. Elementary Mechanics. Principles of Mechanism. Differential and Integral Calculus. Metallurgy. Shades, Shadows, and Linear Perspective. Isometrical Projection. Elements of Mechanical Drawing and Principles of Construction. Shading and Tinting, and drawing from patterns.

Senior Year.

French and German (see Select Course). *Analytical Mechanics*—Strength of Materials. Thermo-dynamics. Theory and Construction of the Steam Engine. Prime Movers. Theory of Machines. Mill work. Examination of Machinery. Mechanical Construction. Machine shop Practice. Architectural Drawing. Drawing from actual Machines. Designs of Machines.

IV. MINING AND METALLURGY.

[Under the direction of Professors BRUSH and ROCKWELL.]

Although this section of the school has been but recently organized, instruction preparatory to mining and metallurgical pursuits has been given in the school since 1857. The Freshman year is the same as in the other courses (see page 51). The Junior year is devoted to special subjects included under Engineering and Mechanics, to Geology, and the French and German languages. The Senior year is occupied with Mining and Metallurgy, and laboratory practice in Chemical Analysis, including Assaying, the determination of the character and value of ores and furnace products, and the discrimination of minerals. Drawing is continued through both years. The lectures on Mining will discuss in detail known facts in regard to Ore Deposits—strata, beds, veins or lodes, stockworks and other irregular masses; Dislocations—faults, and other irregularities; Methods of search; Boring of different kinds with the various apparatus; Tools used in various kinds of mining and in different countries; Blasting; Sinking of shafts; Driving of Levels and Galleries; Timbering, Masonry and Tubbing for securing underground openings; Exploitation, or the opening out of mines and the working away of veins and strata; Transportation underground; Winding or raising the minerals to the surface, and machinery and apparatus; Pumps and Pumping Engines; Ventilation, its principles and

practice, natural and artificial, by furnaces and machines; Lighting—safety lamps; Mechanical Preparation of Ores, etc.

The lectures in Metallurgy will be divided into: (1.) *General Metallurgy*, including the physical and chemical properties of the metals and their ores, and of slags and other furnace products, the different methods used in both the dry and wet way in the extraction of metals; the character and effect of the different kinds of fuel; the materials employed in the construction of furnaces, crucibles, etc.; the details in regard to different forms of furnaces, blast, etc. Under (2.) *Special Metallurgy*, each metal will be considered by itself, its physical and chemical characters given in detail, with the characteristics of its ores, the methods for their assay, and the metallurgical processes employed for the extraction of the metal or metallic compound.

In extension of the present course it is proposed to add at least one year for a higher course, analogous to the higher course in Civil Engineering; this will include four to six months practice in the field in the study of mines and smelting works, to be followed by special Engineering or Chemical studies as applied to Mining and Metallurgy.

PROGRAMME OF STUDIES.

Freshman Year. (See page 51.)

Junior Year.

French and German—(See Select Course.) *Mechanics*—Peck's Elements. Principles of Mechanism. Theory of Steam Engine. *Mathematics*—Mining, Surveying—Shades, Shadows and Linear Perspective. Isometrical Projection. *Civil Engineering*—Strength of Materials. Stability of Arches. Higher and Topographical Surveying. *Geology*—Dana. *Drawing*—Mechanical and Topographical.

Senior Year.

French. (See Select Course.) *Mining*—Lectures. *General and Special Metallurgy*—Lectures. *General Chemistry*—Miller. *Chemical Analysis*—Fresenius. Recitations and Lectures. *Laboratory Practice*—Qualitative and Quantitative Analysis. Use of the Blowpipe. Assaying. *Mineralogy*—Lectures and Practical Exercises. *Zoölogy*—Lectures. *Mechanics*—Application to Engineering. *Drawing.*

V. COURSE IN AGRICULTURE.

[Under the direction of Professors BREWER and JOHNSON.]

This course is intended to prepare the student for the successful management of a farm by putting him in possession of a knowledge of the most approved methods of culture at present employed, and by explaining, so far as the state of learning admits, the reasons for these methods.

It is not expected to give a young man that familiarity with the mechanical operations of husbandry or that business capacity which is essential to the good farmer. These can only be acquired by assuming or sharing the care of a farm.

The course is in consequence adapted to those who are already familiar with rural affairs. Those who are practically ignorant of the varied details of farm practice can scarcely learn them thoroughly in an agricultural school, nor can they profit fully by the lessons proper to such an institution.

The main features of the course are, in addition to the mathematical and other studies of the first year, extended instruction by lecture in the Theory and Practice of Agriculture in all its branches; instruction in the French and German languages, in the accessory sciences, Chemistry, Botany, Zoölogy, Geology, Meteorology, and training in free-hand Drawing and experimental Chemistry.

Opportunities are offered for more particular attention to special branches, such as Horticulture, Forestry, &c., or to any of the sciences taught in the course, in their more detailed or specific applications.

In addition to the above brief programme, other topics of special interest and application in agricultural pursuits, receive attention.

Excursions under the direction of the professors, will teach the methods of out-door observation of natural objects, especially plants and insects useful or injurious to the farmer, as well as furnish illustrations of farming operations.

The Museum of this department has been already described.

SHORTER COURSE.—For the accommodation of those who do not wish to pursue the entire course, the lectures are so arranged, that those upon the subjects of more immediate practical use, are delivered during the Fall and Winter terms. These embrace Agricultural Chemistry, Practical Agriculture, Stock Breeding, and Agricultural Zoölogy. The lectures in the other departments are also accessible to such students. *Those* who desire can thus attend during seven months of the

year such a selection from the studies of the full course as will occupy their time profitably. For such admission to these lectures no examination is required, but testimonials of good character and the ability to profit by the instruction must be presented.

PROGRAMME OF STUDIES.

Freshman Year (see page 51).

Junior Year.

Agricultural Chemistry and Physiology—Structure and Physiology of Plants; Water, Atmosphere, and Soil in their relations to Vegetable Production; Improvement of the Soil by Chemical and Mechanical means. Domestic Animals: the chemical relations of their Food, Digestion, Respiration, Assimilation, and Excretion; Milk, Butter, Cheese, Flesh, and Wool as Agricultural products. Lectures. *Experimental and Analytical Chemistry*—Laboratory practice. *Meteorology*—Academical Lectures. *Physical Geography*—Lectures. *Zoölogy*—Lectures. *Drawing*—Free-hand practice. *French and German*—continued. *Excursions*—Botanical, Zoölogical, etc.

Senior Year.

Agriculture—The staple crops of the United States, their varieties, cultivation, management, and preparation for market. The Care, Breeding and Raising of Domestic Animals. Lectures and Recitations. *Experimental Chemistry*—Laboratory practice. *Agricultural Zoology*—Natural History of Domestic Animals; Insects useful and injurious to Vegetation. Lectures. *Human Anatomy and Physiology*—Lectures. *Geology*—Lectures and Recitations. *Rural Economy*, both American and foreign. Lectures. *French and German*—continued. *Excursions*—Botanical, Zoölogical, etc.

VI. COURSE IN NATURAL HISTORY AND GEOLOGY.

[Under the direction of Professors EATON, VERRILL, and MARSH; Laboratory in Zoölogy, Trumbull Gallery.]

Students in this department who are candidates for a degree, are required to complete the regular course of studies during the Freshman year. A knowledge of Latin and Greek is, also very desirable.

Students, not candidates for a degree may have special courses arranged for them by the Instructors from the studies of the Junior and Senior years, or additional thereto, if desirable.

The instruction in Zoology includes,

First—Courses of Lectures during the second and third terms of the Junior year, on Structural and Systematic Zoölogy; and during the first term of the Senior year, on general and applied Entomology and other special subjects, such as Embryology, Geographical distribution, Nomenclature, *&c.*

Second—Direct practical instruction to special zoölogical and geological students, in the Zoölogical Laboratory, where they are taught to prepare and arrange collections of various animals, and fossils and, by making critical identifications, to become acquainted with scientific literature, and to make dissections in studying comparative anatomy and embryology. They are also, when sufficiently advanced, encouraged to make original investigations. For these, purposes, specimens, both recent and fossil, belonging to the College Museum, are made use of as may be required.

Third—Zoölogical Excursions in connection with the lectures are instituted during the spring and autumn, to afford the students opportunities to collect and observe the habits of both land and marine animals, including those that live only in deep water, and are obtained by dredging. By these excursions several thousand specimens have been added to the College Museum during the past two years, in addition to those retained by some of the students for private collections.

PROGRAMME OF STUDIES.

Freshman Year (see page 51).

Junior Year.

FIRST TERM.

Zoölogy—Daily Laboratory instruction; Zoölogical Excursions. *Botany*—Gray's First Lessons. *Chemistry*—Academical Lectures. *French and German*—Selections.

SECOND TERM.

Zoölogy and Paleontology—Laboratory Practice, Lectures. *Physical Geography*—Lectures and Recitations. *Chemistry*—Laboratory Practice. *French and German*—continued.

THIRD TERM.

Zoölogy and Paleontology—Laboratory Practice, Lectures, Excursions (land and marine). *Botany*—Gray's Manual; Excursions. *Mineralogy*—Dana, Lectures and Practical Exercises. *French*—continued. *Drawing*—Free Hand Practice.

Senior Year.

FIRST TERM.

Zoölogy and Paleontology—Laboratory Practice, Lectures, Excursions. *Geology*—Dana's Manual, Excursions. *Meteorology*—Academical Lectures. *French*—Selections.

SECOND TERM.

Zoölogy and Paleontology—continued. *Botany*—Lectures on special subjects. *Geology*—Dana, Recitations and Lectures. *Anatomy and Physiology*—Academical Lectures. *French*—Selections.

THIRD TERM.

Zoölogy and Paleontology—continued, with Excursions. *Photography*—Practical Instruction. *Preparation of Thesis.* *Examinations* in the studies of the course.

The Zoölogical and Geological Museum, which is accessible to all students, is already extensive and amply sufficient to afford materials for the most advanced studies, as well as for the illustration of lectures.

The College Library, the Scientific School Library, and the private libraries of the Instructors contain a large number of works required for the more advanced studies in this Department which students are allowed to use in the most liberal manner.

A large number of valuable diagrams have been prepared to illustrate the Zoölogical Lectures and the microscopes and other instruments belonging to the Instructors, are freely used for the same purpose.

The large private herbaria and botanical libraries belonging to the Instructors are open to the use of students, to whatever extent they may be needed, thus enabling the more advanced students to prosecute their studies to great advantage.

VII. SELECT COURSE IN SCIENCE AND LITERATURE.

[Under the direction of the Governing Board.]

The Select Course has been arranged to meet the wants of those young men who desire an education based chiefly on mathematical and physical science, and the modern languages, and who are not disposed to pursue either of the special courses already enumerated. The Freshman year is the same as in the other departments of the school. In the second and third years the scholars are trained in a selection from the studies prescribed for the other sections, and they also attend the lectures of President Woolsey and some of the other instructors of the academical department, and recite in text-books which illustrate these lectures.

As it is designed to make this course a valuable means of preparation for advanced scientific studies, it is hoped that especially the younger students who may avail themselves of its advantages will do so with the intention of going forward to pursue still higher branches of learning. Students who enter upon the higher studies taught in the school having that acquaintance with French and German, the mathematics, and the natural sciences, which may be secured by an attendance upon the select course, will pursue their special professional studies with peculiar advantages.

PROGRAMME OF STUDIES.

Freshman Year (see page 51).

Junior Year.

MODERN LANGUAGES.—*French and German*, continued. English Composition and Literature.

MATHEMATICS.—Peck's Mechanics, Norton's Astronomy.

NATURAL SCIENCE.—*Agricultural Chemistry*—Lectures. *Zoölogy*—Lectures and Excursions. *Botany*—Lectures and Excursions. *Mineralogy*—Lectures. *Physical Geography*—Lectures and recitations.

HISTORY.—Recitations.

DRAWING.—Free Hand, and Architectural.

Senior Year.

LANGUAGE.—*French or German*, continued. Lectures on Language and Linguistic Ethnology. Compositions.

NATURAL SCIENCE.—*Botany and Zoölogy*, continued. *Geology*—Recitations and Lectures. *Meteorology*—Lectures. *Human Anatomy and Physiology*—Lectures. *Astronomy*—Lectures.

PHILOSOPHY AND HISTORY.—Lectures and recitations, in *History and Political Philosophy, International Law, Political Economy, Ethics, and Metaphysics.*

Preparation of a graduating thesis.

Higher and Partial Courses of Study.

Graduates of this and other colleges, and other persons who have made some advancement in the study of natural science, may be admitted to the Sheffield Scientific School as students of special branches. Such persons must enrol themselves under the guidance of one or more of the professors, who will be responsible for their instruction; and every facility which the institution affords for the prosecution of their advanced studies will be freely accorded to them. Those who have already taken a Bachelor's degree in Arts, Philosophy or Science, may become candidates for the degree of Doctor of Philosophy. To students of this class the chemical and metallurgical laboratories, the higher course of engineering, the astronomical observatory, and the instructions in the various branches of natural history and geology, present unusual advantages for the prosecution of scientific researches. The shorter course in Agriculture is referred to on page 58.

APPOINTMENT OF STATE STUDENTS.

Announcement of the Appointing Board.

I. By appropriating to the Sheffield Scientific School of Yale College the income of certain funds derived from the sale of United States lands, the State of Connecticut has provided for the gratuitous instruction of a number of pupils in the various departments of the School.

II. The persons to receive this free tuition are to be selected from the candidates who offer themselves, by an Appointing Board, consisting of the Governor, the Lieut.-Governor, the three senior Senators, the Secretary of the State Board of Education, and the Secretary of the Sheffield Scientific School.

III. This privilege of free instruction must be assigned in accordance with the following principles, viz:

1. The candidates for appointment must be citizens of this State.

2. Preference will be given to such as are "fitting themselves for agricultural and mechanical or manufacturing occupations, who are or shall become orphans through the death of a parent in the naval or military service of the United States, and next to them such as are most in need of pecuniary assistance."

3. The appointments must be distributed as far as practicable among the several Counties of the State in proportion to their population.

IV. Candidates nominated by the Appointing Board are to be admitted to the School "upon the same terms and are to be subject to the same rules and discipline as the other pupils of the School, with the single exception that they shall not pay anything for their instruction."

V. The Appointing Board will meet in New Haven on Tuesday, July 16th, and also on Wednesday, September 11th, 1867. Persons desiring to avail themselves of the bounty of the State may apply, in writing, previous to the meeting of the Board, to the Secretary, who will furnish a printed form of application, to be filled up by each candidate, and will present all applications to the Board for their decision.

DANIEL C. GILMAN,
Secretary of the Appointing Board.

CALENDAR.

1866.

Sept. 12th,	Examination of Candidates for admission,	9 A. M., Wednesd
Sept. 13th,	First Term began,	9 A. M., Thursday
Dec. 18th,	First Term ended,	Tuesday.

Winter Vacation of two weeks.

1867.

Jan. 3d,	Second Term began,	9 A. M., Thursday
Feb. 14th,	Annual meeting of the State Visitors,	Thursday.
April 9th,	Second Term ends,	Tuesday.

Spring Vacation of two weeks.

April 24th,	Third Term begins,	9 A. M., Thursday
July 15th,	Exercises of Graduating Class,	Monday.
July 16th,	Examination of Candidates for admission,	9 A. M., Tuesday.
July 16th,	Meeting of the Appointing Board,	Tuesday.
July 18th,	Commencement,	Thursday.

Summer Vacation of eight weeks.

Sept. 11th,	Examination of Candidates for admission,	Wednesday.
Sept. 11th,	First Term begins,	Wednesday.
Dec. 18th,	First Term ends,	Tuesday.

THIRD ANNUAL REPORT

OF THE

SHEFFIELD SCIENTIFIC SCHOOL

OF

YALE COLLEGE:

INCLUDING

I. THE REPORT OF THE VISITORS ON THE PART OF THE STATE OF CONNECTICUT;

II. THE REPORT OF THE GOVERNING BOARD AND FACULTY OF THE SCHOOL;

III. A STATEMENT OF THE ESTABLISHED COURSES OF STUDY.

IV. A LIST OF THE OFFICERS AND STUDENTS.

1867-8.

NEW HAVEN.

PRINTED BY TUTTLE, MOREHOUSE & TAYLOR.

1868.

State Board of Visitors,

CONSTITUTING, WITH THE SECRETARY OF THE SCHOOL, THE BOA
FOR THE APPOINTMENT OF STATE STUDENTS.

May 1867 to May 1868.

GOVERNOR,
His Exc. JAMES E. ENGLISH, New Haven.

LIEUT. GOVERNOR,
His Honor EPHRAIM H. HYDE, Stafford.

STATE SENATORS,
Hon. GEORGE BEACH, Hartford.
Hon. MILES T. GRANGER, North Canaan.
Hon. AMOS J. GALLUP, Sterling.

SECRETARY OF THE STATE BOARD OF EDUCATION,
Rev. BIRDSEY G. NORTHROP, New Haven.

May 1868 to May 1869.

GOVERNOR,
His Exc. JAMES E. ENGLISH, New Haven.

LIEUT. GOVERNOR,
His Honor EPRHAIM H. HYDE, Stafford.

STATE SENATORS,
Hon. EDWIN H. BUGBEE, Dayville.
Hon. ISAAC T. ROGERS, Milford.
Hon. ALBERT AUSTIN, Suffield.

SECRETARY OF THE STATE BOARD OF EDUCATION,
Rev. BIRDSEY G. NORTHROP, New Haven.

SECRETARY OF THE SHEFFIELD SCIENTIFIC SCHOOL,
Prof. DANIEL C. GILMAN, New Haven.

Corporation of Yale College.

PRESIDENT,

Rev. THEODORE D. WOOLSEY, D.D., LL.D.

FELLOWS,

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His Honor EPHRAIM H. HYDE, Stafford.
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Rev. GEORGE J. TILLOTSON, Putnam.
Rev. EDWIN R. GILBERT, Wallingford.
Rev. JOEL H. LINSLEY, D.D., Greenwich.*
Rev. DAVID S. BRAINERD, Lyme.
Rev. ELISHA C. JONES, Southington.
Rev. LEONARD BACON, D.D., New Haven.
Rev. HIRAM P. ARMS, D.D., Norwich Town.
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Hon. JAMES GALLAGHER, New Haven.
Hon. WILLIAM C. STREET, Norwalk.
Hon. CORNELIUS BRAINARD, Higganum.

SECRETARY,

WYLLYS WARNER, M. A.

TREASURER,

HENRY C. KINGSLEY, M. A.

TREASURER'S ASSISTANT.

LUCIUS W. FITCH, M. A.

*Deceased.

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REPORT OF THE BOARD OF VISITORS.

To the General Assembly of the State of Connecticut:

THE undersigned, in behalf of and by vote of the State Board of Visitors of the Sheffield Scientific School, would respectfully report that the Board have attended to the duties required of them, and have paid two regular visits to the School during the year; one, with a view to examine the practical working of the institution under its present management; the other, to select such candidates as might present themselves as applicants for the several scholarships which are open to the students from the State.

The Board were much pleased with the management of the School, and are satisfied that the instruction is conferring important advantages upon the State.

The course of instruction is comprehensive and liberal, and includes all the branches essential to a good practical education; especially is this true in regard to Agriculture and the Mechanic Arts, and other branches of Science in which our people are largely interested.

It is this feature of the School which strongly commends it to public favor and confidence, and which should enlist a still greater and more general interest in its behalf.

With its substantial endowment and able corps of instructors in the various branches of Science, practical as well as theoretical, it holds out advantages which cannot be too

highly prized by the public, and it is to be regretted that a larger number of our young men do not avail themselves of the instruction it affords.

The Board deem it unnecessary to make a detailed report of the condition and management of the School, since a statement will be printed herewith, which was drawn up and presented to them by the Governing Board and Faculty of the Institution, containing all the information desirable to report.

We cheerfully commend the School to the continued confidence and support of the Legislature, and to the friends of Scientific education throughout the State.

In behalf of the State Board of Visitors,

JAMES E. ENGLISH,
Chairman.

New Haven, April 16, 1868.

STATEMENT

RESPECTING THE PROGRESS OF

THE SHEFFIELD SCIENTIFIC SCHOOL

OF YALE COLLEGE,

Presented to the State Board of Visitors,

At their Annual Meeting, March, 1868,

BY THE

GOVERNING BOARD AND FACULTY OF THE INSTITUTION.

Governing Board of the Sheffield Scientific School.

PRESIDENT WOOLSEY.

PROFESSORS DANA, NORTON, LYMAN, SILLIMAN, WHITNEY, BRUSH, GILMAN, JOHNSON, BREWER, ROCKWELL, EATON, MARSH, AND VERRILL.

Historical Note.

The Department of Philosophy and the Arts, to which the Scientific School pertains, was instituted in Yale College, at the Commencement of 1846. In 1860, Sheffield Hall, the gift of Mr. JOSEPH E. SHEFFIELD, of New Haven, was presented to the School, and immediately occupied. He also gave a fund of Fifty Thousand Dollars as the partial endowment of three professorships. In 1866, the Hall was enlarged and refitted a second time at the expense of the original benefactor.

The Congressional appropriation, made in 1862, for the establishment of a Scientific College, was directed to this institution by the General Assembly of 1863.

ANNUAL STATEMENT FOR 1867--8.

I. Aim and Object of this Department of Yale College.

In the first of this series of Annual Statements, made two years ago, we presented an account of the history of the School, of the successive steps by which it had grown to its present extent and assumed its present constitution. In the second, published last year, the external apparatus of the School, its building, instruments, and collections, were described. This time it is deemed appropriate to put forth a more distinct statement than has yet been given of the aim and object of the School—of the part which it is intended to fill in the general scheme of instruction of the community.

Such a statement is the more called for, inasmuch as the position of a school like ours is in some respects peculiar. On the one hand, it is a school of special professional training, and aims to fit men to exercise the callings of engineer, chemist, naturalist, and so on—being so far analogous in its office with the schools of law, medicine, and theology: while, on the other hand, it imposes obligatory courses of a more general character, requiring of its graduates proficiency in other than their professional studies — thus being in part analogous with the College proper, the so-called Academic department. What, it may be inquired, accounts for and justifies, in our intent, this combination? Moreover, our scheme of study is especially marked by the omission of certain branches, and the substitution for them of certain others, respecting the relation and comparative value of which a somewhat lively controversy is now going on in all enlightened countries; and our views and attitude toward this controversy are liable to be misapprehended if not explained by us.

In order that they may be understood, it is necessary that we enter into a brief discussion of the ground and objects of education and discipline. We shall *have in* view only intellectual dis-

cipline—not, of course, as overlooking the importance of moral an religious discipline; but because these must be gained more fro that by which the School is surrounded than from what it is: i is essentially a place for intellectual training, and must be judge by its success as such.

1. *The ends and means of education.*

The object of all education is to increase our capacity of ha piness and usefulness, to enable us the better to enjoy our ow lives and help others to enjoy theirs. In calling forth and trai ing the powers of the individual, it has this double end distinctl in view. Very few are so situated as not to be required to mak their lives valuable to others, that others may help them to live and the few who are not thus compelled are led to it by an e lightened self-interest, since otherwise they miss what is th noblest and highest pleasure of all—that of doing good to tho about them. Every one has a part to play, a work to perfor in the great task of human improvement; and he must be dul fitted for it.

That is a low idea of education which limits it to any partic lar period of life. Even in the humblest occupation, acquisition skill and experience should be ever enabling a man to rise t higher station and to do more valuable work. He is either ver unfortunate, or else worthy of blame on account of wasted oppo tunity, whose life, even to its end, is not constantly becoming greater worth, to himself and others, by growth of knowledge an of power to accomplish. Yet youth is eminently the season acquisition and preparation. Every one's energies must at som time begin to be mainly absorbed in applying what he has acquire in exercising what he has prepared for. The time comes sooner o later, according to circumstances. There are those who have t begin the hard work of life as soon as they have learned to wal and to talk; others are pressed into the ranks at every age. No must active service be begun too late, lest the capacity for it b lost; a life of which too much is spent in preparation is apt to lea to nothing.

If education be taken in this narrow sense, of preparation for th active work of life and for what comes along with this, then tha is evidently the best and most successful education which, in an given case, most thoroughly fits the man for his special work, and at the same time, plants him upon the broadest and deepest found *tion for improvement* both within and without his own department

which least narrows his views and capacities; which makes him the ablest workman, and, along with that, the fullest man. Some occupations, of course, are in their nature more narrowing than others, and that is the most noble and satisfying which demands the widest basis of preparation, and calls into exercise the highest and most varied capacities. But in our community, more than elsewhere, no one is expected to limit himself to preparation for his own craft, since our idea of equality is that each person be encouraged to rise as high above the station in which his birth and circumstances have placed him as his powers and opportunities allow: nay, more; no one *may* thus limit himself, since each is also the citizen of a free state, having powers and responsibilities which he cannot properly sustain without education, and to fit him for which he cannot possibly have more than enough education.

Education is constantly changing its ground and methods, by reason both of the increase of knowledge, and of the multiplication of vocations. It must include within its scope every existing department of human knowledge, and every valuable mode of its application. The Greek was trained in all the sciences that the genius of his countrymen had created or developed—in mathematics, philosophy, rhetoric, and so on: classical and linguistic studies were excluded from his curriculum, because he recognized no tongue but his own as being other than barbarian. The Roman, in addition, had the Greek language and literature as a means of training. At the revival of learning in Europe, the two classical tongues and the works produced in them were the fountains of instruction and models of imitation, and their study assumed a prominence in the scheme of education which has come down by inheritance even to our own day. Meanwhile, however, under their incitement and guidance, the mental activity of modern Europe and its colonies has accumulated abundant treasures of knowledge in every department, in part comparable with, in part greatly overshadowing, those bequeathed to us from antiquity. In literature, in art, in science, in philosophy, in philology, in history, that which is Greek and Roman now forms only a part of the store from which we draw, and on which our education must be founded. None of all this is valuable to the exclusion of the rest. No theory of education can possibly be sound which does not recognize the absolute worth of all human knowledge, or which contemns "facts" of any kind, philological, historical, or scientific. Every branch must have its own followers, so trained that they shall be able to extend and *perfect it, both in itself* and in its relations to other

branches. That man is a specialist whose training unfits him du to appreciate any part of that which is known. But every one us is and must be a specialist, for the field of knowledge h become much too vast to be occupied, or even to be overlook and judged, by any individual. It was long since said that he onl is wise who knows that he knows nothing—and the saying becoming truer every day, not with reference only to what m would fain know, but also to what he already knows. Each m has to turn his back deliberately on much that he would fain p sess, that he may prepare himself for what he has to do. T various branches of knowledge have a comparative value, whi varies with the ground and point of view occupied by each learn There comes a time when we must cease laying a general foundati and build up our own building; and earlier or later, according our different circumstances. A certain common substructure li beneath all the forms of special training, and the broader this made, in any class or country, the higher is the standard of educ tion there. Our mother-tongue is the first thing we learn—a mo important means both of training and enlightenment, and t indispensable preliminary to all that is to follow. Then come t alphabet, the multiplication-table, and the writing-book: no o questions the universal necessity of the "three *r*'s," as they are fam iarly styled ("reading, 'riting and 'rithmetic"). But from th point begins the difference of opinion and dispute as to what mu be added, and in what proportion; the branches of desirab knowledge begin to jostle and crowd out one another. Into t dispute we do not wish or need to enter here: practically, it irreconcilable; there will always be room to maintain that som thing which *I* know and value constitutes a more essential part a true education than what another recommends for the same reaso It is, however, evident that the greater and more varied the ma of human knowledge and the modes of human activity, the earli must the diversity of educational training begin: it is not possib to raise the standard of education at a rate corresponding to t growth of its means and its ends.

Formerly only members of the "learned professions," and ge tlemen who could afford to train themselves after their patter were regarded as needing to be "educated;" and a little of t old feeling remains, though put out of date by the different aspe of affairs in our time. Other occupations used to be mere trad the preparation for which consisted in the acquisition of a certa *amount of mental* and manual dexterity, handed down in guil

and the like, and communicated by private instruction. Now, nearly all the arts of life are raised to a vastly higher plane; the causes and modes of action which they involve are understood; underneath each lies a science, whose comprehension is necessary to their highest and most successful pursuit; a science, too, whose establishment has perhaps required as much learning and insight, as much faithful labor in investigation and logical acuteness of deduction, as much accumulation of wisdom, as high gifts of intellect, as any known branch of human knowledge; whose acquisition costs as thorough preparation, as long study, and as distinguished capacity; and which offers as keen satisfaction to the curious intellect, and has as wide and direct a bearing upon human happiness. All is here included that can give dignity to a calling and to the preparation for it. The scientific man, as he is often called—for example, the engineer, the chemist, the naturalist—is by his occupation challenged to not less ability and disinterestedness, and promised not less usefulness, than the lawyer or physician; his due training is as real a part of the higher education, all that fits him for his work is as truly disciplinary, as anything else in the whole scheme of study.

It is not well possible to lay too much stress upon discipline; but it is comparatively easy to misunderstand what is meant by that word. Anything is disciplinary which prepares the mind for the worthy exercise of its powers, which fits it to receive and utilize truth. There is a too current disposition now-a-days to divorce discipline from acquisition of knowledge, to contemn the useful as ignoble. This is a natural reaction against the opposite tendency, to regard no knowledge as worth acquiring of which the utility is not immediate and obvious. Either error is equally detrimental; and either, when nakedly presented, is sure to be rejected by any enlightened mind; but it is not so easy to avoid some admixture of the one or the other. It might be difficult to say whether an education of bare discipline, always preparing for something to come and never reaching it, or an education of pure cram, thrusting in information that is immediately assimilable and nothing else, would turn out the most of a failure: the result would depend on the force of mind and natural disposition of the individuals subjected to the training: but it is quite as likely that the one scholar would be turned into a mere machine, with capacity and desire for knowledge extinguished, as that the other's powers of combining and reasoning would be destroyed by overloading. *As a matter of fact, every* one is compelled to learn

much which he does not at the time appreciate; which, having only a prospective value, is disciplinary. Thus, what apparently more unfruitful and uninteresting "fact" can there be than that the figure of a pair of straddling legs, with a bar across them (A), is to be called *a*? Many a child has to be flogged into acquiring it. What more barren scheme of "facts" than the multiplication table, or a list of Latin words, or a Greek declension? but by and by, after we have learned them, we come to find their value. And throughout the whole of education, we are constantly getting, under the guidance of others or on faith, what is to be of use to us farther on—and this is all that "discipline" means. The farther on may be a great way off, but it must be somewhere; and at least a good part of it must be within sight or easy reach. There is discipline in the acquisition of all knowledge, because the mere effect of acquirement helps to acquire farther; and also because all knowledge is in itself valuable, as connected with and leading to other knowledge, as enriching and expanding the mind, giving it the taste to acquire and the power to retain. But its worth for discipline lies vastly more in the latter mode of action on the mind than in the former. Nothing is more really disciplinary, in the highest sense, than the gaining of valuable knowledge, along with the comprehension of its value, and the understanding how to use it. Nothing thus given is mere fact or information, nor is the process of so giving it a cram. This is the material on which the mind must work, in order to test and increase its powers, and without which what it may do is only mock work, which exhausts while it exercises. The idea of spending the season of "education" wholly or mainly in a sort of mental gymnastics, of laying out a scheme of preparation for the active work of life which does not include as an essential part the storing of the mind with a variety of useful information, is as erroneous as anything can be. It implies that the rest of life is to be devoted to the acquisition of knowledge, under the guidance of competent instructors, who will see to it that the powers they have trained are directed to worthy objects. It tends directly to make and keep men specialists, turned out as they are with minds imperfectly and desultorily furnished, to give themselves up to work in one direction. He who is to know and love what lies aside from his own narrow track must have learned so much that he has tasted the pleasure of knowing in many departments, that he has a nucleus *of acquisitions* in more than one kind to which new acquisitions *may attach themselves*, that he can overlook to some extent the

field of knowledge, and see what part is more valuable than others, in itself or for him. It would be, no doubt (to adopt a current comparison), a good thing in itself to have gained by steady and consistent drill such a power of concentration as to be able to keep the eye and the thought fixed for half an hour upon the point of a needle without flinching; but one might spend upon this accomplishment so much of the force of his education as to acquire a morbid taste for it, and to be ready to pass his life gazing at needle-points, not knowing that there is anything else better worth doing. When we learn to write, we begin with making pot-hooks and hangers; this is legitimately disciplinary, training the hand for the approaching formation and combination of letters; it would be, indeed, very much grander to start with such a thorough drilling of the eye and hand that Egyptian hieroglyphics, Chinese monograms, and Hebrew and Sanskrit ciphers should come as easily and naturally as English writing; this we might call the "high disciplinary" method; but if the result was (as it would be) that the time when we should have been learning to write had been lost in preliminary preparation for it, and that when writing was a practical necessity to us we had not the art at command, we should have to regard our training as ill directed, and the time spent upon it as thrown away. The ends of education must not be lost sight of in the means; those ends are practical, and must be pursued by means likely to result in their attainment. What is the best discipline for one is not the best for another, even though both may aim at an equal degree of general culture, if their disposition is different, or if they are to follow different walks in life. Each method must be judged by the fruit it yields; that is wasted labor from which in the end no appreciable advantage is derived; the mental effort spent in it might better have been given to something else.

There are those who hold that classical studies are what we have called above "high-disciplinary." This is, however, a wholly erroneous impression—although, perhaps, not illegitimately derived from the claims sometimes put forth in behalf of these studies. Greek and Latin are full of the most direct and far-reaching connections with the rest of our knowledge. Our religion, polity, law, and art come in no small measure from Greece and Rome; our science had its beginning there; the roots of our history are to be traced thither; our literature is modeled on Greek and Roman prototypes; our very language is in great part derived from those sources. The Greeks *and Romans, in* short, were the originators

of our modern culture, in all its departments. They were the most gifted nations of antiquity, our exemplars in nearly every mode of intellectual activity. Their languages are in many respects the finest known instruments of human thought. What is of not less consequence to us, with the investigation of Greek and Roman language and literature has been bound up for a long time past the advance of knowledge and culture; their students have been the intellectual class, a great and powerful guild, with such a past behind it, with such associations clustering about it, wielding such power and enjoying such prestige, that every one must desire admission to it. Classical studies put us in communication with the best thought of both ancient and modern times; they give a kind and degree of mental culture which has been attainable by no other means, and which long custom, as well as its intrinsic character, leads the community to estimate at, to say the least, its full worth.

It is true that, as already noticed, the prominence of the classics as a means of education is upon the wane—not by their loss of absolute value, but by the uprise of other means to the same end, possessing a not less urgent and conspicuous importance; partly, also, by the transfusion of their valuable content into other and modern forms, so that their influence is obtainable indirectly. An immeasurable amount of enlightenment and inspiration is still to be drawn from them, as well as a vast deal of work to be done upon them for the benefit of the race; their knowledge will be the essential pre-requisite to all original and profound investigation of the history of man and human culture; they will always form one of the most important branches of study and means of discipline; they will train the literary taste, the linguistic sense, the faculty of interpretation and criticism, the power to think one's self into the thoughts of other men and other times, the comprehension of humanity and its work. They will demand not less attention in amount than they have hitherto won—although there will be large classes of students whose training may and must be gained without them, by the aid of the abundant fruits of culture which have now been stored up outside of them; and although, on the other hand, he who is versed in them alone can no longer make the same pretension to discipline as formerly. There was a time when to be merely a good Latin and Greek scholar was to be well educated; now, such a one is only a specialist, and may be a narrow-minded pedant, as really deficient in due discipline as if *he knew nothing* but mathematics, or chemistry, or zoölogy.

The objection is often brought against classical study that those who devote to it so large a proportion of the time given to training never carry it, after all, beyond the stage of preliminary discipline, do not begin to derive fruit and enjoyment from it, and drop it abruptly when the work of life is begun, hardly if at all conscious of benefit obtained. Much more is apt to be made of this objection than it is really worth; for, on the one hand, no one is capable of measuring the good that a study does him in exercising the powers of his mind and increasing its range and capacity; and, on the other hand, the higher benefits of education are not within the reach of every one; a host of minds are only limitedly receptive of general culture; are capable, perhaps, of becoming fair specialists in some line which engages all their energies; nothing more. All education is to this extent experimental and liable to failure. The liability does, however, constitute a powerful and valid argument against limiting education to one unvarying pattern, since many a mind which is repelled and stagnated by one set of studies, may be incited to independent and healthy action by another.

We have entered into so much of detail respecting classical study because the scientific courses are mainly peculiar, and exposed to distrust on the part of many in the community, in virtue of the inferior place which they assign to such study, and because they seem to some to deny hereby its value, and cast reproach upon it. This is not at all our intent: we hold that every scientist is the better for all the classical training he can get, even for vastly more than is given in the ordinary college course. Only we also hold that it does not outweigh in importance everything else, and constitute to every one the *summum bonum* of mental training.

These, then, are the fundamental principles on which reposes our opinion of the value of the Scientific School, as a worthy and dignified portion of the general system of education, as a disciplinary institution as well as a professional:—That all knowledge is valuable for discipline, each kind of knowledge giving its own kind of training, and both abundance and variety of positive knowledge being indispensable to the acquirement of that sound judgment which makes the practical wisdom of life, as well as of that love of knowledge for its own sake which conducts to some of the highest and keenest enjoyment that life furnishes; that but a fragment of what is known lies within the reach of any person, and that each, in *view of his own needs* and opportunities, must choose

the part which will be worth most to him; that a system of general education must aim to effect a due compromise, not neglecting the qualification of the pupil for his speciality, but also seeing to it that his mind is expanded, made receptive of truth from every source, and prepared for its utilization; and that there is no other criterion of the comparative dignity and worth of different branches of study than their utility in one or both of these directions.

2. *How the ends of education are here sought to be attained.*

In what ways and by what means we are endeavoring to accomplish what we have undertaken, and to bear our part in the general work of education, may be easily and briefly told.

First, in the so-called regular courses of the school, we give our students a thorough three years' training in certain connected and graded branches of study. These courses are prevailingly mathematical and scientific, being intended to meet the wants of that already large and now rapidly increasing class of pupils whose disposition and aims in life make such a training more valuable to them than one in which the literary and historical element predominates. They have in view the two ends of education, as above laid down; being in part such as directly prepare for the foreseen duties of actual life, in part such as equip the man in general, tending to fit him for sustaining worthily any responsibilities which the future may put upon him. No one is allowed to confine himself to a specialty; a series of general studies, both scientific and literary, runs through the course, and is made obligatory upon all. Linguistic discipline is not ignored; instruction in the French and German languages is made the vehicle of it, and answers to some extent the purposes sought to be attained on a larger scale by the study of Latin and Greek in other modes of education. In the English language also is given such instruction—rhetorical, critical, and historical—as the time permits. In drawing, the attempt is made to give to the eye and hand something of that training which shall enable the latter to represent what the former sees, or what the mind conceives.

The first year is entirely occupied with studies of this more general character. For the other two years, aside from the general obligatory studies, the student is allowed to make his choice between several partially distinct and parallel courses, according to their bearing on his future profession, or upon any other ground determining the preferences of himself and his friends. *Their nature*, and the branches pursued in each, are fully set forth

in the programme given in another part of this Report. One of them, the "Select Course," is of a less special character than the rest, and is intended to meet the wants both of those who desire a training of this general kind, but without having in view any of the professions toward which the other courses more directly conduct; and also, especially, of those who have the leisure and disposition to continue the work of preparation longer before entering at all upon studies having an immediately professional outlook. But the essentially disciplinary nature of the training, alike in all the courses, is attested by the fact that the degree given at graduation is that of Bachelor of Philosophy, the same to all: it vouches that its possessor has gone through a course of instruction, of a somewhat different character from that given in the ordinary collegiate institutions, fitting him to enter with advantage, here or elsewhere, upon higher and yet more special studies, which shall make of him a competent civil engineer, chemist, physician, and so on.

Every exertion is of course used to make the instruction given in the School thorough, to give it a truly scientific character, by carrying each study back to the fundamental principles on which it reposes. Nor do we mean to be content with a less faithful attention to the subjects pursued, nor with a lower standard of individual scholarship, than is required in the Academical department of the College. Our rules respecting attendance, efficient study, and the maintenance of fair standing as a scholar, are strict and strictly enforced. We allow no one to continue member of a class by whose studies he shows himself incapable of profiting, or which he tends to hold back by want of ability or attention.

In the second place, we also offer opportunity for more advanced professional study. In connection with the other, or Academic, branch of the Department of Philosophy and the Arts, the Scientific branch affords facilities for scientific study in various directions up to any desired point of acquisition. On the one hand, those who have gone through the preliminary training and taken the Baccalaureate degree, in either branch, may study here for certain higher degrees, general or special; on the other hand, those whose previous education fits them to follow a free course of study in any of the branches of science represented in the school, for any length of time, without regard to a degree, find here the instruction they need. This was, in fact, according to the original plan of the school, its principal or sole activity: but experience soon showed that but a few *of those who presented* themselves could bear being

limited to special courses; that their equipment by the preparatory schools was insufficient; and that, if the standard of scientific education was to be raised, and men graduated who should be more than mere specialists, it was necessary for the School to undertake a larger share of their training.

Something, we believe, has been already accomplished in this direction, but much more yet remains to be done. Considering the place which Yale College occupies among the educational institutions of the country, and the many advantages for the scholar which are gathered or gathering at this long-established seat of learning, it ought to be, and it is, our ambition to make the Sheffield Scientific School stand in the front rank among the schools of science which are now springing up in such numbers all over our country—to make it turn out the best educated men of science, in virtue both of the amount and quality of the instruction given in it, and of the studies required as preparation for it. We fully intend to rise to such a position, as rapidly as our means shall allow, as rapidly as we shall be enabled to rise by the public opinion and support. At present, we are carrying on the institution upon a larger scale than our funds warrant, and can only plan improvements which we are powerless to execute. The time of three years, to which our courses are now adjusted, is too short for what we have undertaken to introduce into them: we greatly need another year, in order to do justice to our scholars. There is no reason why the well-educated scientific man should expect to prepare himself for his work in less time than the well-educated member of any other of the learned professions. While we are compelled to do so much of the work of preparatory training which, in a more thoroughly organized and graded system of general education, might and should be done in the lower schools, we need the added year, if only for fuller attention to the wider disciplinary branches. In respect to some of these, we stand at a disadvantage. It is thus with regard to drawing: no small part of what we have to teach should be learned, as it is everywhere in Europe, in the earlier stages of education. It is thus with regard to the languages. Not a little of the benefit which ought to be derived from the French and German, and from their literatures, is now lost, because we cannot assume that those who come to us will have been able to obtain in the lower schools good instruction in those tongues, and because we must therefore commence their study from the very beginning. It is chiefly in view of this fact that we have lately *added a certain* amount of Latin to the prospective requirements

for admission, from the autumn of 1869 onward. Apart from the great and undeniable value of a knowledge of the Latin for its own sake to every educated man in every department, and its absolute indispensability, even, to the student of many branches of science, there is no other way in which the grammatical and philological practice needed to enable one to take up the modern languages successfully and acquire them rapidly can be so easily and surely gained as by the study of this tongue, for which facilities are found in every good school, and which forms a natural and customary part of every preparatory course. It has, indeed, been found by experience that five sixths of the students hitherto received into the School have had as much instruction in Latin as our plan contemplates; and the advantage of it has been distinctly felt.

One serious difficulty against which we have to contend—a difficulty growing in part out of the want of due adjustment between our institution and the preparatory schools, in part out of other causes—is the want of sufficient preparation on the part of those who offer themselves for admission. Every year, many candidates are wholly rejected, while others are brought in only after a season of probation and extra study. It seems difficult to make young men, parents, and teachers understand that the entrance examination is a serious and penetrating one, not only in the mathematical, but also in the more general English branches. Candidates and their friends do not realize how much of the satisfaction and profit of the course is lost when one comes so scantily fitted and insufficiently trained that he just scrapes in, or enters under conditions, with examinations to be made up and passed a second time, thus keeping up the scraping process for an indefinite period, perhaps a large part of the whole of his stay in the School. We hope for a marked improvement in this respect as our plan comes to be better comprehended, and as such institutions as ours come to be distinctly calculated for in the preparatory schools.

II. The need of an increased Endowment.

In consequence of the bestowal upon this institution of the income derived from the national land-grant, the Governing Board were led at once to enlarge the courses of instruction previously maintained, and to enlist the services of additional professors, in order that the "Connecticut College of Agriculture and the Mechanic Arts" might sustain a character worthy of the reputation of the State *in matters of education*, and corresponding in some

degree at least with the superior advantages long enjoyed in the Academic Department of Yale College. This enlargement of the scope of the Sheffield Scientific School has been justified by the experience of the past two years. Students have come to us from every portion of the country; and not only so, but gentlemen concerned in the establishment of kindred institutions have visited New Haven from almost every State which has received the national grant, in order to see the actual operations of our school and gather information from our experience. Such visitors have always been welcomed, and from many of them we expect in our turn to derive important assistance and counsel. We have also been gratified to see abundant indications that the school is growing in the good will of the people of Connecticut. The newspapers of the State have spoken favorably of our work, and we have enrolled among our scholars more from Connecticut than the number for which the State made provision. Our collections and museums are also growing, and the instructors of the school are more and more called upon to coöperate in local educational and scientific labors.

While we are thus encouraged by the evidences of increasing influence, we are disheartened by the fact that our funds are still so inadequate as to prevent us from doing all which we should like to do for the promotion of science and scientific education. The portion of the national grant which fell to the share of Connecticut was inconsiderable compared with that which was received by New York, Pennsylvania, Massachusetts, and other large States. The only other fund on which we can depend is made up from the gifts of a few individuals, and is less than sixty thousand dollars. Tuition fees add indeed to our resources, but not so much as might be expected from the number of students whose names appear upon the roll, because the fees of so many are remitted. We feel in consequence that our Institution, for the work it proposes to perform, and for the character which it aims at maintaining, is still but imperfectly endowed; and we are persuaded that if men of property and of liberality would but look into our circumstances with close attention, they would discover inviting opportunities for the employment of their wealth. Impressed with these considerations, the Governing Board determined early last autumn to make an effort to increase the endowment of the Scientific School. They invited a number of the citizens of New Haven to come together and listen to a statement of the wants of the School. *Governor English*, Chairman of the Board of Visitors, who has

shown the same appreciative interest in the School which was manifested by his predecessors, Governor Buckingham and Governor Hawley, indicated his confidence in our enterprise by an early subscription of one thousand dollars; Mr. Joseph Sampson, of New York, a summer resident in New Haven, paid a like amount; Mr. Wells Southworth increased a former subscription which he had made so that it amounted also to one thousand dollars; Messrs. William & E. T. Fitch subscribed as a firm the sum of five hundred dollars; and Hon. Morris Tyler, late Mayor of the city, subscribed three hundred dollars. Several other gentlemen likewise promised their aid, but have not as yet signified the amount they will give. We are not without hopes that, when the business of the country is more prosperous, our friends will liberally sustain an institution in which they avow a decided interest.

At the request of the Governing Board, Mr. Luke E. Wood, of Clinton, has also called upon a few persons resident in other parts of the State and has laid before them a statement of our hopes and plans. As a brief explanation of our wants, the following paper, signed by the various members of the Governing Board, has been printed, and sent to a few gentlemen.

CIRCULAR.

"The undersigned, officers in the Sheffield Scientific School of Yale College, regarding ourselves as the representatives or trustees of the friends of scientific education, in the maintenance of an important public interest, feel compelled to lay before a few of those for whom we act a simple statement of the condition and prospects of this rapidly growing institution.

"It is well known that we are maintaining at New Haven, under all the advantages which come from a connection with Yale College, a modern school of theoretical and practical Science, in which young men may secure for themselves not only thorough mental discipline, but also an acquaintance with such branches of useful knowledge as Chemistry, Civil Engineering, Mining, Metallurgy, Mechanics, Agriculture, and other departments of natural and physical Science.

"In this undertaking we have been dependent, like all other higher establishments of learning, not only in this country, but abroad, on the liberality of public and private benefactors. We have received generous aid, far beyond our expectations, and we point with pleasure to the results which are due, in no small degree, to this timely assistance. A spacious and convenient edifice has been provided for the School, and equipped with valuable collections of apparatus, instruments, books, diagrams, models, and specimens; a corps of not less than twelve professors devote themselves to this department of *the College; hundreds* of young men have already

been fitted here for the various callings of life; and one hundred and twenty scholars are this year receiving our instructions. We have also endeavored to be of service to the public at large by lectures gratuitously given to mechanics and farmers, and to general audiences in different parts of the State. It would not be modest in us to say more; but so much as this seemed necessary to exhibit the foundations which have here been laid.

"We cannot continue this work, however, on its present scale, without assistance from the friends of scientific education. During the past two years our income has fallen considerably short of meeting our expenses, and we have been forced to draw upon a small accumulation (now exhausted) which peculiar circumstances in a former year had placed at our command. More than one of our professors are giving their services to the school gratuitously; others are on half-pay: and not one receives from the school a salary at all adequate to the maintenance of his family. Several of our number have declined far more lucrative posts elsewhere, from a desire to help in building up this new department of Yale College. But this state of things cannot and ought not to continue long. We shall be obliged to contract our plans, and lessen our useful activity, unless we are assisted. We do not ask for help on personal considerations, but we do appeal with confidence in behalf of the interests of education, and in behalf of a young and prosperous institution, to those gentlemen of intelligence and wealth by whose encouraging words we have repeatedly been cheered, and whose opportunities have enabled them to see the importance of such a school as is committed to our care.

"There are several departments of the school, not yet endowed, to which large sums might be directed with a certainty of benefiting for generations to come the education of our countrymen, and the development of the national resources. We are hopeful that new features will thus from time to time be added to this institution; but now we ask especially for contributions applicable to all the current necessities of the establishment—the income only to be expended, and the principal to remain forever as 'THE GENERAL FUND OF THE SCIENTIFIC SCHOOL.'

"As the nucleus of this fund, we have already received—in addition to the specific gifts of Mr. Sheffield and others—the sum of Ten Thousand Dollars. We need at least One Hundred Thousand Dollars. We believe that among the capitalists of the country there are many who will take pleasure in giving their coöperation to sustain, on a scale corresponding with its importance, a school on which so much depends."

In justification of this appeal, repeated now with even more earnestness than when it was originally made, it may be well to show why it is that a well ordered school of science is so costly; especially as the erroneous and injurious rumor has gone abroad, and has made an impression on some of our best friends, that the *scientific departments* of Yale College are sufficiently endowed.

Although the growth of this institution, since 1860, has been rapid, the demands upon it have increased with still greater rapidity. Prior to the date just named, there were but two classes of students, those engaged in the chemical laboratory and those who were studying civil engineering. Now, in accordance with public demands, as our programmes of study indicate, special professional or technical education is provided for chemists, metallurgists, civil, mining, and mechanical engineers, agriculturalists, geologists, naturalists; and we are also called upon to provide a general disciplinary course of study, closely corresponding, as we have already said, to the academic course; and likewise higher courses of instruction suited to the wants of those who have already taken their first degree and are candidates for a second. Thus the students of this department are divided into not less than seventeen distinct groups, or squads, each having its own prescribed curriculum; and there are also several independent students pursuing their special researches. All this involves of necessity a large corps of teachers, every one of whom aims to be proficient in certain chosen branches of study. It cannot be expected that a professor of mining should be a teacher of botany, or that a professor of agriculture should take charge of the instruction in civil engineering. Every teacher in the school has abundant occupation for his time and strength in endeavoring to keep up with the progress of science in his department, and in imparting to his classes the instruction they require. We are only kept back by the lack of a sufficient number of teachers, from making the regular courses extend through a period of four years.

The entire endowment available for the current expenses of the Scientific School yields less than fourteen thousand dollars, including the income of the congressional grant and of the library fund; to this may be added the income received from tuition—money which amounted last year to eight thousand dollars; and out of the aggregate are to be taken the payments for salaries, repairs, fuel, insurance, library-books, and the innumerable miscellaneous expenses which are indispensable. It is hardly necessary to add that no pecuniary assistance is received from the general funds of Yale College, though our students are freely admitted to the academic lectures. From this brief statement, it must be evident, we think, that our resources are far from being ample.

When we hear of the funds which are at the command of kindred establishments, especially in foreign countries; when we con-

sider the rapid advances which are making in every department of scientific research and of practical skill; when we think of the fine collections of books, apparatus, models, and specimens which ampler resources would immediately provide for us; when we consider how many useful branches of knowledge are now wholly omitted or are inadequately represented in our present curriculum, we earnestly hope, for the good of science and of the country, that the day is not distant when our means will be largely increased. We are persuaded, that if men of wealth would but look into the mode in which the funds of the college are employed, would consider the care with which they are controled, and the good which results from the income they yield, it would be clear that permanent and substantial good is secured for the country by every endowment which this University receives. It has been truly said elsewhere that "the treasury of Yale College can show dollar for dollar of every gift entrusted to it."

III. Additions to the Scientific Collections.

1. ZOOLOGY.

Many important additions have been made to the Zoölogical collection during the past year, both by donations and exchanges. In the early part of the year, Mr. F. H. Bradley made some valuable collections at Zorritos and Paita, Peru, in continuation of his explorations of the west tropical coast of America, but returned in April. Acknowledgments are due to George Perie, Esq., general manager of the Pacific Steam Navigation Company, for aiding Mr. Bradley's exploration by the reduction of fares and freight from Callao and Guayaquil to Panama, and to David Hoadly, Esq., President of the Panama R. R. Company, and F. W. G. Bellowes, Vice-President of the Pacific Mail Steamship Company, for giving him a free passage home and free transportation for all his collections. The College is, also, under obligations to E. P. Larkin, Esq., for hospitalities and aid given to Mr. Bradley at Zorritos, Peru.

Among the other more important collections are a valuable lot of new and rare Corals and Echinoderms from Brazil, received from Prof. C. Fred. Hartt; a fine set of Pacific-Ocean Corals presented by Mr. Horace Mann; an interesting collection of shells and Echinoderms, many of them new to us, brought from the Gulf of California by Capt. J. Pedersen; numerous native insects from Amos Shepard, Esq.; a valuable lot of authentically labelled insects *from Edward Norton*, Esq.; and a large and important collection

of authentically labelled Corals and Echinoderms sent by Dr. Chr. Lütken, from the University Museum of Copenhagen. For forwarding the last and other collections from and to Europe, free of expense, thanks are due to the Smithsonian Institution.

One of the most interesting specimens received during the year is a young specimen, preserved entire in alcohol, of the rare and curious Central American Tapir, recently described by Prof. Theod. Gill, and previously known to naturalists only by a few skulls and an imperfect skeleton. This valuable donation was received from J. H. Sternbergh, Esq.

The important work of labelling and permanently cataloguing the entire collection has progressed rapidly and satisfactorily during the year. Mr. S. I. Smith has nearly completed the catalogue of crustacea, and has greatly advanced that of the insects. Mr. H. S. Williams has identified and catalogued a large number of shells and most of the reptiles. Mr. G. H. Perkins has done the same for large numbers of shells. Mr. F. L. Miles gave important aid in cataloguing the fishes, and other students have given assistance in the same manner. Most of the corals and echinoderms and many shells, remaining unarranged last year, have been identified and catalogued by Prof. Verrill, who has also described many of the new and rarer species in the Transactions of the Connecticut Academy of Arts and Sciences.

Several special collections have, also, been sent away to other naturalists for identification or for monographic work, and some of these have already been returned.

The number of collections sent away and received in exchange has also greatly increased, and, as rapidly as our time and resources will admit, this system will be still farther developed. Several expeditions have been fitted out or materially aided with apparatus and alcohol for making zoölogical collections. From some of these valuable returns will be expected during the spring.

LIST OF DONATIONS DURING THE YEAR.

PANAMA EXPEDITION. Subscription of 1867. *Collected by F. H. Bradley.*—Fishes, and Marine Invertebrates, from Paita, Peru; Reptiles, Fishes, Insects, and Marine Invertebrates, Zorritos, Peru; Mollusca, Crustacea, and Insects, Tumbez, Peru; Insects and Crustacea, Guayaquil, Equador; Mollusca, Panama and Aspinwall,	9750
Frank L. Dubois, U. S. N.—Lepidoptera, Panama,	106
J. F. Reeve.—Squilla, Monstrosities, and Coral Snake, Guayaquil, Equador,	5
F. H. Bradley, Y. C. 1863.—Mammals, Menobranchi, Reptiles, Fishes, Insects, and Mollusca, Crawfordsville, Ind.; Turtle, Insects, and Mollusca, Illinois; Mollusca, New York; Insects, New Haven, and Milford, Ohio,	995
J. H. Sternbergh, Panama.—Tapir (*Elasmognathus Bairdii*), entire young in alcohol,	1

Amos Shepard, Esq., Plantsville, Conn.—Insects, Bats, Mole, Shrew, Plantsville; Salamander, Troy, New York, ... 475
Chas. R. Dodge, Department of Agriculture, Washington, D. C.—Insects, Washington and Illinois, ... 82
C. W. Chapman, New Haven.—Insects, New Haven, ... 19
A. G. Clark (S. S. S.).—Insects, Ohio and New Haven, ... 42
C. M. Clark (S. S. S.).—Reptiles, Myriapod, Texas, ... 8
G. A. Jackson (S. S. S.).—Orthoptera, Graylock Mt., North Adams, Mass., 19
Chas. J. Sheffield (S. S. S.).—Crustacea, Long Island, ... 12
Landon Ketchum and *Chas. J. Sheffield*.—Insects, South America, ... 117
Edward Norton (Class of 1844), Farmington, Conn.—Insects, mostly identified species, from Connecticut, Florida, and Louisiana; Shells, Florida, 136
G. F. Bailey and *F. L. Miles* (S. S. S.).—Fish, New Haven, ... 12
Mrs. Amos Binney, New Haven.—Bat, New Haven, ... 1
T. S. Gold (Y. C. 1838), West Cornwall, Conn.—Larvæ of the currant saw-fly, W. Cornwall, ... 30
J. H. Grove (S. S. S.).—Insects, etc., Danville, Pa. 26
Joshua Coit (Y. C., 1819), New Haven.—Insects, New Haven, ... 3
D. W. Harris (S. S. S.).—Insects, New Haven, ... 2
Dr. H. A. Dubois, New Haven.—Spiders from Colorado, ... 2
W. W. Denslow, Esq., New York.—Insects and Land Shells, New York, .. 3
Mineralogical Excursion.—Insects from New Jersey, ... 7
Yale Missionary Society.—Shells, Corals and Echinoderms, Pacific Ocean, 40
Prof. W. H. Brewer.—Starfishes, New Hampshire; Insects, New Haven, 4
Prof. Addison Van Name.—Insects, New Haven, ... 21
Prof. O. C. Marsh.—Skulls and Bones, Fish, Insect, New Haven, ... 10
Prof. D. C. Eaton.—Bird's eggs, Reptiles, Insects, Myriapods, New Haven, 44
Prof. G. J. Brush.—Echinus, Florida; Insect, New Haven, ... 2
E. S. Morse, Salem, Mass.—Worms parasitic in the gills of clam, Beverly, Mass. 5
William Cook (S. S. S., Class of 1861, Y. C.).—Insects, New Haven, ... 3
Horace Mann, Cambridge, Mass.—Corals (*Pocillipora*, etc.), Hawaiian Isls. 44
Samuel Swift (S. S. S.).—Snake, New Haven, ... 1
Mrs. L. H. Smith, Norway, Me.—Insects, Norway, Me., ... 20
Miss Lillie Blaikie, Boston, Mass.—Corals, Bryozoa, Sponge, Ebon Isl., ... 8
H. S. Williams (S. S. S.).—Insects, New Haven; Shells, Watch Hill, R. I., 25
Henry Richards, Hillsboro, Ill.—Orthoptera, Nebraska, ... 6
Horace Mansfield, New Haven.—Larvæ of *Prionus*, New Haven, ... 22
E. T. Nelson, B. A. (S. S. S.).—Insects, Land and Fresh-water Shells, Ohio; Insects, Shells, New Haven, ... 407
F. L. Miles (S. S. S.).—Fish, Reptiles, Mollusca, Crustacea, New Haven; Fish, Reptiles, Insects, Austerlitz, N. Y. 478
H. S. Williams and *F. W. Stowell* (S. S. S.).—Crustacea, Long Island Sound, 85
A Daggett, Jr., New Haven.—Insects, New Haven, ... 2
Prof. A. E. Verrill.—Insects, New Haven and vicinity, Norway, Me., New York; Starfishes, Echini, Mollusca, Crustacea, Annelids, Portland, Me.; Limnæa, Salem, Mass.; Reptiles, New Haven; Reptiles, Bird's nest and eggs, Orange Co., N. Y.; Myriapods, Norway, Me. 403
Prof. A. E. Verrill and *Zoological Class* (Class 1868, S. S. S.).—From Zoological Excursions, Reptiles, Fishes, Mollusca, Insects, Worms, Crustacea, Radiates, New Haven and vicinity, ... 719
S. I. Smith (S. S. S., 1867).—Insects, Norway, Me.; Insects, Reptiles, Mollusca, New Haven, ... 377
J. M. Chapin (Y. C.)—Shells and Corals 39
F. W. Stowell (S. S. S.).—Crustacea and Annelids, L. I. Sound, ... 16
Stephen H. Bronson, M.D. (S. S. S.).—Sertularia, and anatomical preparations of Crustacea, New Haven, ... 4
J. Matthew Jones, Halifax, N. S.—Marine Invertebrates, Bermuda and Nova Scotia, ... 80
G. H. Perkins, B. A. (S. S. S.).—Turtle shell, New Hampshire; Shells, New Haven, ... 51
H. R. Mighels, Carson City, Nevada.—Shells from California, ... 116

G. D. Miller (Y. C.).—Birds' eggs from northern New York, etc.; Shells, Corals, Echinoderms, various localities, ... 755
W. C. Hickok, M. D., Burlington, Vt.—Rare Shells, Lake Champlain, ... 25
F. H. Hathorn (Class of 1867).—Strombus gigas, West Indies, ... 1
G. H. Landis (Class of 1867).—Strombus gigas, West Indies, ... 1
R. Munson, Hamden.—Fish, Hamden, ... 6
Seth Cruttenden, New Haven.—Pure-blood Terrier, ... 1
John J. Matthias (Class 1866, S. S. S.), New Haven.—Skin of Snake and Whale's tooth, South America, ... 2
Prof. B. Silliman.—Crustacea, Mollusca, Fishes, etc., Coast of Nicaragua; Cyclops, Clear Lake, Cal., ... 560

RECEIVED IN EXCHANGE.

A. Assmann, Breslau, Prussia.—European Lepidoptera and Coleoptera, 208 species, ... 619
Boston Society of Natural History.—Corals and Echinoderms, various localities, 38 species; Crustacea, 13 species, ... 145
Essex Institute, Salem, Mass.—Ophiurians, Zanzibar, 3 species; Corals, Singapore, ... 9
University Museum, Copenhagen, through Dr. Chr. Lütken.—Echinoderms, Acalephs, Polyps, Corals, 145 species, ... 220
G. H. Perkins (S. S. S.).—Gorgonia, Shells, Africa; Fresh-water Shells, Illinois, etc., 70 species, ... 709
Prof. C. Fred. Hartt, New York.—Corals, Echinoderms, Worms, Crustacea, Spiders, Mollusca, Fishes, and Reptiles, Coast of Brazil; Corals and Echinoderms, St. Thomas, ... 300
Dr. Albert Kölliker, Würzburg, Bavaria.—Microscopic preparations of Gorgonidæ, ... 35
Charles G. Brewster, Boston, Mass.—Corals, Singapore; Crustacea and Radiata, Europe, 25 species, ... 50

BY PURCHASE.

Fred A. Munson, New Haven.—Tænia solium, ... 1
Dr. Chas. H. Van Patten, 12 species of Birds, Guatemala, ... 12

COLLECTIONS SENT AWAY IN EXCHANGE.

A. Assmann, Breslau, Prussia.—Insects from New England, 201 species, 635
Henri de Saussure, Geneva.—Orthoptera from New England, 43 species, 141
Dr. P. P. Carpenter, Montreal, Canada.—Mollusca from the West coast of America, 62 species, ... 361
Museum of Comparative Zoölogy, Cambridge, Mass.—Mollusca from various localities, 45 species; Echinoderms and Corals, 67 species, ... 338
Edwin Bicknell, Salem, Mass.—Echinoderms, spines and corals, 49 species, 49
Prof. T. Glover, Department of Agriculture, Washington, D. C.—New England Lepidoptera, 10 species, ... 13
S. H. Scudder, Boston Society of Natural History.—New England Insects, 13 species, ... 25
Essex Institute, Salem, Mass.—Echinoderms from the West coast of America, 11 species, ... 23
E. T. Nelson (S. S. S.).—Marine Shells, New England, 15 species, ... 28
F. W. Stowell (S. S. S.).—Marine shells, New England, 15 species, ... 27
G. H. Perkins (S. S. S.).—Corals and shells, 6 species, ... 14
A. Shepard, Esq., Plantsville, Ct.—New England Butterflies, 36 species, .. 46
Dr. Albert Kölliker, Würzburg, Bavaria,—Halcyonoid Polyps, 104 species, 168
Boston Society of Natural History.—Echinoderms and corals, West coast of America, etc., 21 species, ... 43
E. P. Larkin, Esq.—Corals, West coast of America, 26 species, ... 26

2. MINING AND METALLURGICAL MUSEUM.

The following gifts have been received in the mining and metallurgical museum, from the parties whose names are specified in connection with each donation.

Gould & Curry Silver Mining Co., through *Louis Janin, Esq.*, Superintendent, Virginia City, Nevada.—Suite of specimens illustrative of the ores and methods of extraction in use in the Gould & Curry Mill, with specimens of amalgam, retorted metal, and bullion.

Ellsworth Daggett, PH.B. (S. S. S. 1864), Superintendent of stamp-mill, Virginia City.—A specimen of crystallized amalgam; also drawings of stamps and machinery of the Gould & Curry Co.

Gideon E. Moore, PH.B. (S. S. S. 1861), Assayer of the Gould & Curry Metallurgical Works, Virginia City.—Suite of mill products, and manuscript description of the Washoe Metallurgical Processes.

R. L. Crooke, Esq. (Sheffield Laboratory, 1863–6), Metallurgist, New York.—A collection of specimens of commercial pig-lead, solder, and other lead alloys; also specimens of ingot tin and tin-foil.

R. L. Crooke, Esq and *J. A. Macdonald, Esq.* (Sheffield Laboratory, 1864–66), Metal Refiners.—A suite of Canadian antimony-ores, with cake of metallic antimony and furnace products illustrative of the smelting of antimony ores; also specimens of spelter dross, with ingots of refined zinc manufactured therefrom.

Prof. B. Silliman.—A suite of specimens illustrative of the gold quartz mines in Grass Valley, California; and of the telluret gold ores of Tuolumne Co., besides extensive collections of gold, silver and copper, ores from other portions of California, Idaho, Nevada, and Arizona. Also, a collection of tin ores from Durango, Mexico, and Idaho.

Park, McCurdy & Co., Copper Refining Works, Pittsburgh.—Specimens of sheet-copper, and copper-bars and rods.

Park, Brothers & Co., Black Diamond Steel Works, Pittsburgh, Pa.—A suite of specimens of blister, ingot, and bar steel illustrative of the manufacture of steel by the crucible and cementation processes.

A. Henry, Esq., Agent of the East Tennessee Iron Works.—Specimens of manganesian iron ore and pig-iron from East Tennessee.

Frank Semple, Esq. (Sheffield Laboratory, 1862–4), Pittsburgh.—Specimen of cyano-nitrid of titanium from the hearth of a blast furnace.

East Tennessee Copper Co.—Specimen of ingot copper.

Gen. H. P. Adams, Superintendent of Golconda Mine, Canada.—Collection of quartzose ores and auriferous sand.

Prof. A. P. Rockwell.—Suite of Specimens illustrating the dressing of copper ores at the Lake Superior Copper Mines; also iron ores from near Marquette.

Prof. A. Agassiz, Harvard University.—Suite of specimens from Calumet Mine, Lake Superior.

The Colwells, Shaw & Willard Mnfg. Co., New York.—Specimens of lead-encased block tin pipe.

Prof J. S. Lippincott, Esq.—Specimens of cryolite and chemical products obtained therefrom.

Prof. A. E. Verrill.—Iron ores from Orange and Essex Cos., New York.

Prof. O. D. Allen (S. S. S. 1861), Institute Technology, Boston.—Specimens of crystallized slags and furnace products.

Dr. Chas. Johnson, Georgetown, Colorado.—Silver and gold ores from Colorado.

Saml. Coit, Esq., President.—Specimens of spathic iron ore, pig iron, bar, and steel from the works of Silver-Steel Co., Roxbury, Conn.

Thos. F Collier, Esq. (S. S. S. 1866-8), St. Louis, Mo.—Lead and Iron ores from Missouri.

H. E. Day, Esq., President.—Suite of copper and silver ores from the Suffield Mine, Canada East.

Prof. Peter Collier (Y. C. 1861, and Sheffield Laboratory 1861-6), University of Vermont.—Collection of quartzose gold ores from western North Carolina.

Charles J. Sheffield, Esq. (Sheffield Laboratory, 1865--7).—Suite of quartzose and pyritiferous gold ores from Brasstown Creek, North Carolina.

Hegeler & Matthiessen, La Salle Spelter Works, Ill.—An ingot of metallic zinc.

Prof. J. Johnston, Wesleyan University.—Specimens of zinc ores and metallic zinc from Bellevue Zinc Works, Mineral Point, Wis.

Dr. E. S. T. Arnold, Yonkers, N. Y.—Gold and silver ores from California and Nevada.

Hon. C. N. Riotte, late U. S. Minister to Costa Rica.—Specimens of gold ores from Costa Rica.

H. S. Williams, Esq. (S. S. S. 1868).—Specimen of zincite from Mine Hill, N. J.

Dr. R. A. Fisher (Sheffield Laboratory, 1858-9), Grass Valley, Cal.—Specimens of gold and silver ores from California and Mexico.

John H. Grove, Esq. (Sheffield Laboratory, 1865-8), Danville, Pa.—Specimens of iron ores and pig-iron from the Montour Iron Works, Pa.

Joseph Wharton, Esq., Philadelphia.—Model of a block of Belgian zinc furnaces at the Lehigh Zinc Works, Pa.; also specimens of metallic nickel and nickel alloys from the Camden Nickel Works.

Reuben J. Johnson, Esq., Salem, Iowa.—Specimens of gold and silver ores from Montana.

Purchased.—A collection of ores and furnace products from the Mansfield Copper-Slate District, Prussia.

3. GEOLOGY.

During the past year the Geological Collections of the College have been largely increased, mainly through donations and by purchases. Considerable progress has also been made in cataloguing and rearranging the collections already in the Museum, and in this work Dr. W. N. Rice, Mr. E. T. Nelson and Mr. G. H. Perkins, students in this department, have rendered important assistance.

Among the recent acquisitions that deserve especial mention are those illustrating the Ichnology of the Connecticut Valley, the more important of which are a series of ten slabs of fossil foot-prints, collected by Mr. T. M. Stoughton, of Gill, Mass.; forty-seven slabs collected by Mr. O. H. Lebourveau; and several fine specimens obtained of Mr. Roswell Field, all from the vicinity of Turners' Falls, Mass., and purchased with the income of the Peabody Fund. In addition to these, two valuable slabs from the same locality were presented to the Museum by Mr. T. M. Stoughton, and five by Prof. O. C. Marsh. The Connecticut River, and New Haven, Hartford and Springfield Railroads, with great liberality, transported

these extensive collections to New Haven free of charge. The Middlesex Quarry Company, of Portland, Ct., has also recently presented to this department four interesting specimens, Messrs. Brainard & Co. two slabs, and the Shaler & Hall Company one slab of foot-prints, all from the Portland quarries, and forming together a valuable addition to the Museum. His Honor, Mayor Sperry, of New Haven, has kindly allowed the entire collection of Ichnology to remain for the present in the State House.

One of the most interesting additions to the geological collections during the past year is a remarkably perfect skeleton of the Irish fossil Elk (*Megaceros Hibernicus*), presented to the Museum by Prof. O. C. Marsh. This specimen was found in a peat-bog near Limerick, Ireland, about twenty years since, and is undoubtedly one of the largest, if not the largest, ever discovered, the antlers having an expanse of thirteen feet and two inches.

A large and very valuable collection of Tertiary fossils from the greensand beds of the well known Squankum Marl Company, near Farmingdale, N. J., has recently been presented to the Peabody Museum by O. B. Kinne, Esq., of New York. This important acquisition is of peculiar interest, as it consists of several thousand specimens, all from a single locality, and many of them new to science, a study of which will doubtless solve the question as to the exact age of this remarkable marl deposit, now proving of such great value as a fertilizer. This collection has been brought together, with great labor and expense, during the last five years, by Mr. Kinne, while Superintendent of the Squankum Company, and the thanks of all friends of science are justly due to him for his zeal and generosity.

Among the additions to the Museum, previous to the present year, not hitherto publicly acknowledged, the following are worthy of particular mention:—An interesting collection of Silurian fossils from Tennessee, presented to the Cabinet by Prof. J. M. Safford, of Nashville. A suite of fossil plants from Maryland, received from R. P. Uhler, Esq., of Baltimore. A fine series of Silurian and Devonian fossils from Indiana and Michigan, presented by Prof. Alex. Winchell, of Michigan University; and a large collection of Post-Tertiary fossils, from Maine, Labrador, and Canada, purchased of Dr. A. S. Packard, Jr., of Salem, Mass.

DONATIONS RECEIVED DURING THE PAST YEAR.

Dr. E. Foreman, Eatonsville, Md.—Fossil impressions from the Trias, near Emmetsburg, Md, ... 30
Sylvanus Buller, Esq.—Fossils from Ionia Co., Mich., ... 4
Dr. A. T. Pratt (Y. C. 1846).—Fossils from Mt. Cassius, Syria, ... 2
Reuben J. Johnson, Esq., Salem, Henry Co, Iowa.—Silicified wood from Montana, ... 6
Miss Sarah E. Hemenway, Salem, Iowa.—Geode from Jackson, Iowa. 1
Henry Richards, Esq., Monroe, Orange Co., N. Y.—Rocks and fossils from Dakota, ... 30
H. C. Kingsley, Esq. (Yale College).—Slab with glacial markings, from the Hamilton of Ulster Co., N. Y., ... 1
George M. Kellogg. Esq., Keokuk, Iowa.—Fossils from St. Louis limestone the of Iowa, ... 20
Wabash College, Indiana.—One slab containing Pentremites, from the Subcarboniferous of Crawfordsville, Ind., ... 1
Sir Wm. E. Logan, Montreal, C. E.—Fine specimen of *Eozoon Canadense*, from the Laurentian of Petite Nation, Canada, ... 1
Prof. O. C. Marsh (Yale College).—Skeleton of fossil Elk from Ireland; Fossil foot-prints from Turners' Falls, Mass.; Silurian and Devonian fossils, New York; Cretaceous and Tertiary fossils, New Jersey; European fossils from various localities, ... 2630
T. M. Stoughton, Esq., Gill, Mass.—Foot-prints from Turners' Falls, Mass., .. 2
Middlesex Quarry Co., Portland, Ct.— " " Portland, ... 4
Brainard & Co. Quarry Co., Portland, Ct.—Foot-prints from Portland, ... 2
Shaler & Hall Quarry Co, Portland, Ct.— " " " 1
Col. E. Jewett, Utica, N. Y.—Tracks and impressions from the Clinton of New Hartford, N. Y., ... 30
Prof. G. F. Barker (Yale College).—*Paradoxides Harlani*, from Braintree, Mass., ... 1
F. B. Meek, Esq. Washington, D. C.—Devonian and Carboniferous fossils from Kansas, ... 15
Dr. F. V. Hayden, Washington, D. C.—Cretaceous fossils from Nebraska, ... 30
E. P. Larkin, Esq., Zorritos, Peru, and *F. H. Bradley, Esq*., New Haven, Ct.—Tertiary fossils from Peru, ... 878
Dr. George A. Ward, New Haven, Ct.—Triassic fishes from Sunderland, Mass., ... 2
Prof. A. E. Verrill (Yale College).—Post-Tertiary Fossils from Port Kent, N. Y., ... 20
J. E. Clayton, Esq., New York.—Fossils from Nevada, ... 12
Henry Hotchkiss, Esq., New Haven, Ct.—Specimens from Artesian well, New Haven, ... 5
Prof. S. S. Haldeman, Columbia, Pa.—*Scolithus linearis* from Columbia, Pa, 3
Prof. B. Silliman (Yale College).—Mastodon remains from near Jamestown, Tuolumne Co., Cal., ... 2
Chas. J. Sheffield, (Sheffield S. S.), New Haven, Ct.—Fossil fern from Coal-measures of Tennessee, ... 1
Dr. Thomas T. Minor, New Haven, Ct.—Fossils from Nebraska, ... 7
O. B. Kinne, Esq., New York.—Vertebrate and invertebrate Tertiary fossils from Upper Greensand bed of Squankum, N. J., ... 3000
Wm. N. Longworth, Esq. (Class 1844, Yale College), Louisville, Ky.—Fossil plants, fishes, shells and corals, from Devonian of Kentucky, ... 200
Prof. W. C. Kerr, Raleigh, N. C.—Palæotrochis and enclosing rock from North Carolina, ... 50
W. G. Mixter, (Sheffield S. S.), Rock Island, Ill.—Corals from Devonian of Illinois, ... 7
R. T. Nelson (Sheffield S. S.), Galion, O.—Devonian fossils from Ohio, ... 100
G. H. Perkins, (Sheffield S. S.), Galesburg, Ill.—Subcarboniferous fossils from Iowa and Illinois, ... 30
H. S. Williams, (Sheffield S. S.), Ithaca, N. Y.—Devonian fossils from Ithaca, N. Y., ... 20

H. Barnes, Esq., C. E., Halifax, N. S.—Coal plants from Sydney, Cape Breton, 15
Prof. C. F. Hartt, Poughkeepsie, N. Y.—Fossils from the Silurian of New Brunswick, and the Cretaceous of Brazil, 30
G. D. Miller, Esq. (Class of 1869, Yale College), New Haven, Ct.—Fossils from various localities, 6
Prof. C. A. White, Iowa City, Iowa.—Fossil corals from Iowa, 2

COLLECTIONS OBTAINED BY PURCHASE.

F. H. Bradley, Esq., New Haven, Ct.—Fish remains from the Hamilton of Western New York, 3500
H. A. Greene, Esq., Mt. Morris, N. Y.—Fish remains from the Hamilton and Chemung of New York, 1000
J. A. Allen, Esq., Cambridge, Mass.—Devonian and Subcarboniferous fossils from Iowa, 250
T. M. Stoughton, Esq., Gill, Mass.—Fossil foot-prints from Turners' Falls, Mass., 10
O. H. Lebourveau, Esq., Montague, Mass.—Fossil foot-prints from near Turners' Falls, Mass., 47
Roswell Field, Esq., Gill, Mass.—Fossil foot-prints from near Turners' Falls, Mass., 4

4. MUSEUM OF ARCHÆOLOGY AND ETHNOLOGY.

This department of the College has been established within the past year, in response to the rapidly increasing interest in questions relating to the origin, antiquity, and early history of Man. It has for its main object the formation of collections illustrating what is known of the aboriginal races of North and South America, both in pre-historic time, and during their subsequent progress toward civilization; and also, so far as may be necessary for comparison, of collections relating to the primitive races of other countries.

The acquisitions already made are deposited in the new Art Building, where ample accommodations for further additions have been provided. The facilities for collecting specimens relating to the early races of America are every year rapidly diminishing, and it is earnestly hoped that all friends of the College will lose no opportunity of securing for this new Museum objects of interest bearing upon the important branch of science it is designed to illustrate.

Among the articles which it is especially desirable to obtain are the following:—

1. Implements of stone, such as axes, gouges, chisels, mortars, pestles, pipes, tomahawks, spear-heads, arrow-heads, &c.

2. Implements of copper or bronze, such as axes, chisels, spear-heads, knives, &c.

3. Articles of earthen-ware, such as images of any kind, vases, pots, pipes, &c.

4. Articles of dress, weapons, domestic utensils, &c., of the various tribes of North and South American Indians, and also of the Eskimos.

5. Images and sculptures, or casts of them, particularly those made by the *early inhabitants of* Mexico, Central America, Peru, and Chili.

6. Mummies, skeletons, or parts of skeletons, especially the skulls, of any of the above named races.

Specimens intended for the Museum may be sent to the care of Prof. O. C. Marsh.

5. OTHER GIFTS.

The collection of Maps and Charts has received an important gift from the authorities of the United States Coast Survey, through Prof. J. E. Hilgard, *Assistant in charge*, at the request of Hon. O. S. Ferry (Y. C. 1841), U. S. Senator from Connecticut, —consisting of a series, nearly complete, of the admirable charts which are published by the Survey.

By the liberality of E. C. Read, Esq., of New Haven, a valuable eight-day sidereal chronometer has been added to the instruments of the Astronomical Observatory. The thanks of the Governing Board have been returned to the donors of these acceptable gifts.

IV. Public Lectures to Mechanics.

The third annual course of public lectures to Mechanics and others who are interested in scientific subjects has been delivered during the past year. Notwithstanding the repeated inclemency of the weather, the Hall was uniformly filled on Monday and Thursday evenings, and the speakers have repeatedly been called upon to exceed the appointed limits of an hour.

PROGRAMME.

I.	Jan. 23.	The Paris Exposition,	Prof. Norton.
II.	" 27.	Meteorites, Fire-balls, and Shooting Stars,	" Lyman.
III.	" 30.	Salt, its Origin and Uses,	" Brewer.
IV.	Feb. 3.	Physical Geography of New England,	" Gilman.
V.	" 6.	Trees and Timber of New England,	" Eaton.
VI.	" 10.	Roots of Plants,	" Johnson.
VII.	" 13.	Leaves of Plants,	" Johnson.
VIII.	" 17.	Language as an Instrument,	" Whitney.
IX.	" 20.	The Languages of the World,	" Whitney.
X.	" 24.	The Copper Regions of Lake Superior,	" Rockwell.
XI.	" 27.	Geology of New Haven and its vicinity,	" Marsh.
XII.	Mar. 2.	Machinery of the Paris Exposition,	" Norton.
XIII.	" 5.	Metallurgy of Lead,	" Brush.
XIV.	" 9.	Metallurgy of Tin,	" Brush.
XV.	" 12.	Light, and how we See,	" Wright.
XVI.	" 16.	The Canker Worm,	" Verrill.
XVII.	" 19.	Water for Drinking in Cities,	" Brewer.
XVIII.	" 23.	Analysis of the Spectrum,	" Barker.

V. Relations with the State Board of Agriculture.

At the annual meeting of the Board of Agriculture of the State of Connecticut, held in Hartford Jan. 14, 15, and 16, two public lectures were delivered by the Professor of Zoology, Mr. Verrill, on "The laws of Reproduction in Cattle," and two by the Norton Professor of Agriculture, Mr. Brewer, on "Parasitic Diseases that injure the flesh of Cattle for food," and on the "Possibilities and Limits of Improvement in Breeds of Cattle." Prof. S. W. Johnson has continued to be a member of the Board, and is also Chemist to the State Agricultural Society.

VI. Sunday Evening Lectures.

During the last two years, several courses of Sunday evening lectures have been given to the students of this department. The first course was delivered by several clergymen connected with the college and with the churches of New Haven, on practical, moral, and religious themes. President Woolsey, Professors Fisher, Dwight, Day, and Rev. Messrs. Leonard Bacon, William Patton, Edwin Harwood, Thomas H. Burch, and W. W. Andrews, occupied successive evenings. This was followed by a course of lectures from Professor Fisher, on the early History of the Christian Church. A course of lectures by Prof. D. C. Gilman, on Biblical Geography, has since been given.

VII. Prizes.

The Governing Board for several years past have been enabled to offer prizes for the encouragement of special industry and application in the different departments of the school. These premiums have been placed at the disposal of the instructors by generous gifts from the Berzelius Society and other friends of the school. With the exception of the Prize in Chemistry offered by Prof. Silliman, such funds are now exhausted. It would be gratifying to the instructors if gentlemen who are interested in promoting the scholarship of our students would enable the Board to continue these rewards. We should welcome either a permanent fund, of which only the income would be expended, like the Townsend and DeForest Prizes in Yale College, or occasional offers of sums of moderate amount for success in examinations, or for improvement in scholarship, or for investigations in some department of scientific research, or for good English compositions, or for any

other appropriate object. One or two hundred dollars a year for promoting scientific excursions would prove a great stimulus to the enthusiasm of the students.

The Berzelius prizes awarded at the anniversary in July, 1867, were as follows: First prize of $30, in gold, to Sidney I. Smith of Norway, Me., for an essay "On Secondary Causes in the Geographical Distribution of Plants and Animals;" Second prize of $20, in gold, divided between William G. Mixter of Rock Island, Ill., and Daniel H. Wells of Upper Aquebogue, N. Y., for essays of equal merit, by the first named "On the Chemistry of Fuel," and by the last named "On the Improved Methods of Determination employed in the U. S. Coast Survey."

Berzelius Prizes for 1868.

By the liberality of the Berzelius Association, the Governing Board are enabled to offer this year four prizes, equal in rank and equal in amount, for the four best essays presented on the subjects below mentioned.

Any member of the S. S. School may compete for any or all of these prizes, except the first named, which is offered only to those who are candidates for the degree of Ph.B. in one of the regular courses of the school.

Essays must be submitted to the Secretary of the school (through the Post Office or in person), on or before June 1st, 1868.

SUBJECTS.

I. For the best English Composition, $10 in gold.
   1. An inquiry into the various estimates which have been placed on the intellectual and moral character of Lord Bacon.
   2. An examination of the various theories in respect to the Origin of Language.
   3. The Newspaper as a power in modern civilization.

II. In Civil and Mechanical Engineering. For the best essay, $10 in gold.
   1. On the most important recent improvements in the construction of Rail Roads.
   2. On the economic applications of Electricity.

III. In Natural History. For the best essay, $10 in gold.
   1. A comparison of the extinct and existing faunas or floras of any country.
   2. The influence of insects on the vegetation of any region.

IV. In Chemistry and Physics. For the best essay, $10 in gold.
   1. On Osmose.
   2. On recent developments of the Alkali industry.

VIII. Anniversary Exercises.

The anniversary exercises of this department were held in Sheffield Hall, on the Monday (July 15, 1867) before the College Commencement. The State Board of Visitors were represented by Governor English, Lieutenant Governor Hyde, Senator George Beach, and Secretary Birdsey G. Northrop. President Woolsey and other members of the Corporation and of the different Faculties of the College were also present. The programme was as follows:

PROGRAMME.

Theses marked with a star (*) were not publicly read.

1. Prayer by the President.
2. Thesis, "A comparison of the Agriculture of the United States, France, England, and Germany;" by PETER H GROVE, Danville, Pa.
3. Prize Essay, "On the Chemistry of Fuel;" by WILLIAM G. MIXTER, Rock Island, Ill.
4. Thesis,* "On the supposed conversion of ammonia into nitric acid by atmospheric oxygen;" by LUTHER H. WOOD, West Haven.
5. Prize Essay, "On the improved methods of determination employed in the U. S. Coast Survey;" by DANIEL H. WELLS, Upper Aquebogue, N. Y.
6. Thesis,* "On certain principles of Political Economy applicable to our national development;" by CHARLES H. HUBBARD, Sandusky, Ohio.
7. Solution of a Problem in Constructive Engineering; by LYMAN S. FERRY, New Haven, and by VOLNEY G. BARBOUR, Bristol.
8. Thesis,* "Constituent Minerals of West Rock, New Haven;" by WILLIAM G. MIXTER, Rock Island, Ill.
9. Thesis,* "On the Aqueous Vapor of the Atmosphere;" by ROBERT M. GROVE, Danville, Pa.
10. Thesis,* "On the Iron resources of the United States;" by JOSEPH T. WHITTLESEY, New Haven.
11. Thesis,* "On Deep Sea Soundings;" by JOHN KENNEDY BEESON, Uniontown, Pa.
12. Thesis,* "A monograph of the Orthoptera of the State of Maine;" by SIDNEY I. SMITH, Norway, Me.
13. Prize Essay, "On secondary causes in the Geographical Distribution of Plants and Animals;" by SIDNEY I. SMITH, Norway, Me.
14. Thesis, "An illustration of the principle of Cephalization in a natural classification of Echinoderms;" by WILLIAM H NILES, Cambridge, Mass.
15. Thesis, "On Darwin's Theory of the Origin of Species;" by WILLIAM N. RICE (B.A. Wesl.), Springfield, Mass.

After the exercises of the graduating class were concluded, there was a brief intermission, and an address was then delivered by Professor C. S. Lyman, on "Scientific Education in its Relations to Industry." By the liberality of a friend of the School, this address has since been printed and distributed. Hon. Justin S. Morrill, U. S. Senator from Vermont, author of the Congressional bill appropriating a portion of the national domain for the endowment of Colleges of Agriculture and the Mechanic Arts, has been invited by the Governing Board to deliver an address at the anniversary in July, 1868.

IX. Degrees.

At the Commencement, July 17, 1867, the following persons, who had completed their courses of study in this department, and had successfully passed the final examination, were admitted by the Corporation of Yale College to the Degrees which are specified:

DOCTOR OF PHILOSOPHY.

WILLIAM N. RICE (B.A. Wesl.), Springfield, Mass., Professor elect in Wesl. Univ.

BACHELORS OF PHILOSOPHY.

VOLNEY GILES BARBOUR,	*Bristol.*
JOHN KENNEDY BEESON,	*Uniontown, Pa.*
ALFRED CALDWELL,	*Wheeling, West Va..*
SAMUEL HOSMER CHITTENDEN,	*Madison.*
LYMAN STEWART FERRY,	*New Haven.*
PETER H GROVE,	*Danville, Pa.*
ROBERT MICHAEL GROVE,	*Danville, Pa.*
CHARLES HENRY HUBBARD,	*Sandusky, O.*
WILLIAM GILBERT MIXTER,	*Rock Island, Ill.*
WILLIAM HARMON NILES,	*Cambridge, Mass.*
SIDNEY IRVING SMITH,	*Norway, Me.*
DANIEL HALSEY WELLS,	*Upper Aquebogue, N. Y.*
JOSEPH THOMPSON WHITTELSEY,	*New Haven.*
LUTHER HODGES WOOD,	*West Haven.*

X. Library and Reading Room.

By the generosity of Mr. Sheffield, a special fund of $10,000 is provided for the maintenance of a library and reading room. By a gift of $2,000, from the various gentlemen whose names were mentioned in our last report, arrangements were also made for the purchase of such reference books as are needed as the foundation of the library. A part of this money has been expended within the year, by Prof. W. A. Norton, who was enabled, in his recent visit to Europe, to make a selection of recent books in the various branches of Civil Engineering. Many valuable donations of books have also been received, the titles of which are specified below. A Catalogue of the collection, upon cards, has been completed.

The list of Periodicals received is as follows. Many similar journals, which might be looked for in this list, are received in part by the Library of Yale College and in part by the Professors privately.

PERIODICALS RECEIVED.

AMERICAN.

Title.	How received.
American Journal of Science and Arts.	By gift of the Editors.
Scientific American.	"
American Artisan.	By subscription.
American Rail Road *Journal.*	"

Title.	How received.
American Gas Light Journal.	By subscription.
American Journal of Mining.	"
American Journal of Pharmacy.	"
American Farmer.	By gift of Messrs. Silliman & Dana
Horticulturist.	By subscription.
American Agriculturist.	By gift of the Publishers.
Journal of the N. Y. State Agricultural Society.	By gift of the Society.
American Journal of Horticulture.	By subscription.
New England Farmer.	"
Southern Planter.	By gift of the Publishers.
Practical Entomologist.	By subscription.
California Mining and Scientific Press.	By gift of Prof. Brewer.
California Farmer.	By gift of the Editors.
Journal of the Franklin Institute.	By subscription.
American Naturalist.	"
American Journal of Conchology.	"
Transactions of the Connecticut Academy.	By gift of the Academy.
American Publishers' Circular.	By gift of the Publishers.
Bulletin of the Iron and Steel Association.	By gift of Prof. Brush.
BRITISH.	
Civil Engineer and Architect's Journal.	By subscription.
Practical Mechanic's Journal.	"
Engineer.	"
Mining Journal.	"
Farmer's Magazine.	"
Gardeners' Chronicle.	"
Zoölogist.	"
Ibis.	"
Annals and Magazine of Natural History.	"
Monthly Notices of the Astronomical Society.	"
Mechanics' Magazine.	By gift of Messrs. Silliman & Dana
British Journal of Photography.	"
Ironmonger.	"
Journal of the Society of Arts.	"
Journal of the Chemical Society.	By subscription.
Chemical News.	"
CONTINENTAL.	
Cosmos.	By gift of Messrs. Silliman & Dana
Comptes Rendus de l'Acad. des Sciences.	"
Les Mondes.	"
Moniteur de la Photographie.	"
Chemisches Central Blatt.	By subscription.
Annales de Chimie et de Physique.	"
Berichte der deutschen Chemischen Gesellschaft.	"
Zeitschrift für Chemie.	"
Zeitschrift der Oberschlesischen Berg-Vereins.	"
Annalen der Landwirthschaft in Preussen.	"
Civilingenieur.	"
Polytechnisches Central-Blatt.	"
Technologiste.	"
Botanische Zeitung.	"
Hedwigia.	"
Zeitschrift für Wissenschaftliche Zoologie.	"
Archiv für Anthropologie.	"
Revue Universelle des Mines.	"
Journal d'Agriculture Pratique.	"
Revue et Magazin de Zoologie.	"
Annales des Ponts et Chaussées.	"
Bulletin de la Société Chimique de Paris.	"

CHIEF DONATIONS OF BOOKS RECEIVED IN THE LIBRARY, 1866 & 7.

Mr. Joseph E. Sheffield.—Natural History of the State of New York, 20 vols. quarto; U. S. Pacific Rail Road Reports, 13 vols. quarto.

Prof. William H. Brewer.—Appleton's New American Cyclopaedia, 16 vols. R. octavo.

Messrs. Silliman & Dana.—(*Eds. Amer. Jour. Science*), Sitzungsberichte der Akad. der Wissenschaften zu Wien, 1854–1867, (in numbers) 59 vols. 8vo.; Monatsberichte der Akademie zu Berlin, 1846–63, (in nos. nearly complete), 17 vols. 8vo: Jahrb. d. geologischen Reichsanstalt zu Wien, 1850–62, 10 vols. R. 8vo; Comptes Rendus de l'Academie des Sciences, Paris, 14 vols. complete, quarto, and several numbers; recent books and current periodicals, American and foreign, in various departments of science, about 150 vols. Total, 250 vols.

Prof. S. W. Johnson.—The Farmer's Magazine, London, 1839–1857, 36 vols. 8vo; Ratzeburg's Forst Insecten, 1839, 2 vols. 4to; Ladrey, Chemie de la Viticulture; and eighteen other octavo volumes.

Prof. George J. Brush.—United States Coast Survey, 1851–63, 12 vols. 4to; Phil. Acad. of Sciences Proceedings, 8 vols. 8vo; Zeitschrift d. Berg. akademie zu Freiberg, 8vo.

Prof. A. P. Rockwell.—Wagner's Jahresbericht der Chem. Technologie, 4 vols. 8vo.

Prof. W. A. Norton.—Jones's Observ. on Zodiacal Light, one vol. quarto, and seven quarto scientific pamphlets.

Prof. James D. Dana.—Lenoir's Gallerie d. ausgezeichn. Naturforscher, one vol. plates, folio and four other volumes.

Prof. Benj. Silliman.—Testarum conchyliorum Index; one vol. plates, folio; Johnson's Direct. of Gardening, 8vo; Hutchings' Scenes in California, 8vo; Bakewell's Geology, 1839, 8vo, and two other volumes.

Prof. C. S. Lyman.—Practical Mechanics' Journal, 10 vols. quarto.

Prof. W. D. Whitney.—Max Muller's Lectures on Language, 2 vols. 12mo; Whitney's Lectures on Language, 12mo.

Prof. D. C. Eaton.—Agassiz's Nat. Hist. of the U. S., 4 vols. quarto.

Prof. D. C. Gilman.—Illustrated Catalogue and Jury Reports of the great Exhib. of 1851, 6 vols. R. 8vo.; Jury Reports of Exposition of 1855, 2 vols. R. 8vo; United States Census of 1860, 4 vols, 4to.

U. S. Dept. of Agriculture.—Report and Bulletin.

U. S. Coast Survey.—Report for 1865.

U. S. Naval Observatory.—Wash. Astronom. Observations, 1851–2, 1864, 1865. 3 vols. quarto.

Class of 1867, Sheff. Sci. School.—Photographic Likenesses of the members of the Class; bound in full Turkey, quarto.

T. S. Gold, Esq. (Y. C. 1838), Sec. State Bd. of Agric.—Reports of Maine and Michigan Boards of Agricult., and of N. Y. State Agric. Soc., 3 vols. 8vo.

R. T. Welles, Esq. (Y. C. 1864), Chief Clerk U. S. Navy Dept.—Davis's Report on Interoceanic Canals and R. Roads. 8vo.

Mr. F. C. Beach, (S. S. S.)—The Pneumatic Dispatch.

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ck Converse Beach,	*Stratford.*
deTrafford Blackstone,	*Norwich.*
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Samuel Nelson Holmes,	*Boonton, N. J.*
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James Edward McCall,	*New York City.*
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Henry Herbert Swinburne,	*Newport, R. I.*
Clarence Augustus Warren,	*Louisville, Ky.*
John George Watson,	*Ayr, C. W.*
William Bartlett Wilcox,	*Portland.*

SPECIAL STUDENTS

PURSUING A HIGHER OR A PARTIAL COURSE.

Joseph Sampson Adam,	*Canaan.*
Wilbur Olin Atwater, B.A. Wesleyan.	*Brandon, Vt.*
Volney Giles Barbour, PH.B.	*Bristol.*
Beverly Scott Burton, PH.B.	*Philadelphia, Pa.*
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Joseph Robinson Folsom,	*Fair Haven.*
Julian Griggs,	*Middletown, N. Y.*
David Hanford,	*Chaplin.*
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William Rufus Hopson,	*Bridgeport.*
Joseph Courten Hornblower,	*Paterson, N. J.*
Nelson Powell Hulst, B.A.	*Washington, D. C.*
Edward Whiting Johnson,	*Norwich.*
Joseph Goodhue Kendall,	*New York City.*
Charles Byron Koon,	*Auburn, N. Y.*
Augustus Washington Littleton,	*Peoria, Ill.*
Houston Lowe,	*Dayton, O.*
Wallace Ellingwood Mather,	*Andover, Mass.*
Henry Hoyt Perry,	*Southport.*
Charles Henrique Pope,	*Louisville, Ky.*
Walter Charles Riotte,	*New York City.*
Joseph John Skinner,	*Wallingford.*
George Frederick Stone,	*Hartford.*
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Charles Alvah Weed,	*Binghamton, N. Y.*
Horace Franklin Whitman,	*Philadelphia, Pa.*
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Charles Thruston Ballard,	*Louisville, Ky.*
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Townshend Stith Brandegee,	*Berlin.*
Daniel Seymour Brinsmade,	*Trumbull.*
Charles Peter Brooks,	*Blooming Grove, N.*
Ralph Howard Burkett,	*Hartford.*
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Peter Shoenberger,	*Cincinnati, O.*
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Angus Cameron, LL.B.	*LeRoy, N. Y.*
Sherman Hartwell Chapman, B.A.	*Bridgeport.*
Thomas Fassitt Collier, B.A. Wash. Univ., St. Louis.	*St. Louis, Mo.*
Henry Coleman,	*Nahant, Mass.*
William Richard Cutter,	*Woburn, Mass.*
Rev. John Dickinson,	*Westville.*
Jesse Durland,	*Warwick, N. Y.*

James G. Gardner,	*Troy, N. Y.*
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Charles Shepard Rodman, M.D.	*New Haven.*
George Baldwin Selden,	*Rochester, N. Y.*
Charles Joseph Sheffield,	*New Haven.*
Sidney Irving Smith, PH.B.	*New Haven.*
Daniel Halsey Wells, PH.B.	*Upper Aquebogue, N. Y.*

SUMMARY.

Seniors,	27
Juniors,	35
Freshmen,	36
Special Students,	27
TOTAL,	125

GEOGRAPHICAL DISTRIBUTION.

Connecticut,†	47	Dist. of Columbia,	2
New York,	27	Illinois,	2
Massachusetts,	9	Delaware,	1
Pennsylvania,	8	Maryland,	1
Kentucky,	6	Rhode Island,	1
Ohio,	5	North Carolina,	1
Missouri,	4	West Virginia,	1
New Jersey,	3	Michigan,	1
Vermont,	3	Canada,	1
Wisconsin,	2		

* Deceased. † The number of State Scholarships is thirty-three.

PROGRAMME.

Object.

The object of the Sheffield Scientific School is to provide young men with instruction in the various departments of Mathematical, Physical and Natural Science. By an act of the Legislature it has been constituted the Connecticut college for the promotion of Agriculture and the Mechanic Arts, and has received the benefit of the land appropriation bestowed by Congress upon this Commonwealth. As a department of Yale College it shares in the advantages which pertain to that long established seat of learning. Private generosity has provided additional facilities for the prosecution of scientific studies.

Organization.

The care of the institution is intrusted, under the President and Fellows of Yale College, to a Governing Board of thirteen professors, who are also the instructors of the school, each of them representing some department of learning. Several other assistants are also employed.

The regular courses of study are arranged in seven sections, as follows:

I. Chemistry and Mineralogy.
II. Civil Engineering.
III. Mechanics.
IV. Mining and Metallurgy.
V. Agriculture.
VI. Natural History and Geology.
VII. Select Course in Science and Literature.

The arrangements of all these sections are fully exhibited below.

Building and Apparatus.

Sheffield Hall, in which most of the instruction is given, is a large and well arranged building containing recitation and lecture rooms for all the departments of the school, a hall for public assemblies and lectures, a drawing room for the engineering class laboratories for chemical and metallurgical investigations, a photographical room, an astronomical observatory, a museum a library

and reading room, besides studies for some of the professors, where their private technical libraries and collections are kept.

The arrangements of Sheffield Hall, and also the various collections of the School and of the College (so far as the latter are applicable to this department), were described in the report for 1866–7.

APPARATUS OF INSTRUCTION.

The following is a summary statement of the material possessions applicable to the purposes of instruction:

I. *Pertaining to Sheffield Hall.*

1. Laboratories in Chemistry, Metallurgy, Photography and Zoology. (A laboratory in Physics and Mechanics is still very much wanted.)
2. Metallurgical Museum of Ores, Furnace Products, etc. (an extensive and increasing collection).
3. Agricultural Museum of Soils, Fertilizers, useful and injurious Insects, etc.
4. Astronomical Observatory, having a very good equatorial telescope, by Clarke and Son of Cambridge, a meridian circle, etc.
5. A library and reading room, containing books of reference and a selection of German, French, English and American scientific journals.
6. A collection of models in Architecture, Civil Engineering and Mechanics, and of diagrams adapted to public lectures.
7. A collection of Maps and Charts, topographical, hydrographical, geological, etc.
8. The private mineralogical cabinet of Prof. Brush, the herbariums of Professors Eaton and Brewer, the collection of native birds of Professor Whitney, the astronomical instruments of Professor Lyman,—all freely accessible to qualified students.

II. *Pertaining to the University.*

1. The College Library, consisting of 48,000 volumes, and the Society Libraries, consisting of 26,000 volumes; TOTAL, 74,000 volumes.
2. Two Reading Rooms, one containing the newspapers and literary journals of England and the United States;—the other, quarterlies and monthlies in various languages and departments of learning.
3. The Cabinet of Minerals and Fossils,—an extensive and well known collection.
4. The Collections in Natural History.
   (These collections and the mineral cabinet will be removed to the Peabody Museum when it is built; a fund of $150,000 having been given for this purpose by Geo. Peabody, Esq., of London.)
5. Apparatus in Physics and Chemistry adapted to and employed in public lectures.
6. The Collections of the Yale School of the Fine Arts, including the well known "Jarves collection" of early Italian paintings.
7. Gymnasium for physical training.

Classification of the Students.

The pupils of the scientific school are thus classified:

1. Those who are pursuing a systematic and prescribed course of study, extending through three years, and leading to the degree of Bachelor of Philosophy;

2. Those who have already been admitted to the degree of *Bachelor of Philosophy*, Science, or Arts, and are pursuing an ad

vanced course of study leading to the degree of Doctor of Philosophy, or in some cases to the degree of Civil Engineer;

3. Special students, who have already made a certain degree of proficiency in some department of science, and are now pursuing special scientific studies under the personal direction of some of the professors.

Degrees.

The degrees below named are conferred by the Corporption of Yale College on students who have passed the required examinations at the close of their course, and are recommended as candidates by the Governing Board of the School:

1. Bachelor of Philosophy, conferred at the termination of three years' study in any one of the several sections of the School;

2. Doctor of Philosophy, conferred on those who have already been admitted to the degree of Bachelor in Philosophy, Science, or Arts (in this or any other college), and who have successfully pursued in this college a higher course of study,—when the Baccalaureate degree does not indicate an acquaintance with the Latin and Greek languages, the candidate being required to show some proficiency in these studies;

3. Civil Engineer, conferred on students of the engineering section who have already taken the degree of Ph.B., and subsequently pursue with success the higher course of engineering.

4. In addition to the diploma of the Corporation, the instructors will give, if requested to do so, a formal certificate stating how long the student has been a member of the institution, and in what department of study he is proficient. This certificate will be awarded only to meritorious students, after a thorough examination, and will be considered as the personal recommendation of the professors who sign it.

Conditions of Admission; and of Graduation.

All applicants for admission must be not less than sixteen years of age, and must bring satisfactory testimonials of good character.

1. TO THE REGULAR THREE-YEAR COURSES AS CANDIDATES FOR THE DEGREE OF PH.B.

Students desiring to go through any one of the prescribed three-year courses of the school, as candidates for the degree of Bachelor of Philosophy, must sustain an examination in the following books, or their equivalents:

Algebra—Davies, as far as General Theory of Equations. *Geometry*—Davies Legendre.* *Plane Trigonometry*, including Analytical Trigonometry—Loomis Davies. *The Elements of Natural Philosophy. Arithmetic* (including the Met system of weights and measures). *English Grammar, Geography, and the Histo of the United States.*

Some acquaintance with the Latin language is regarded as e sential to the most efficient progress in the studies of the scho and accordingly it will be made a subject for the preliminary e amination after the examination of 1868. All who desire it can readily secure instruction in this tongue that none should negle to secure the advantages which come from its study. In th French and German classes great assistance will be derived fro previous training in Latin,—while but little will be gained by th preliminary study of French and German, as every class at prese begins with the rudiments of these languages. Latin is indispe sable to the advanced students of Zoology and Botany, and important in understanding the nomenclature of all departments science.

In consequence of the incomplete preparation of many of th candidates, it is proper to say that the examination for admissi is strict and full. As the studies above named are not pursued the school, and are essential to successful progress, no one can b received as a scholar who is not well acquainted with the branches.

Candidates for advanced standing in the three-year courses a examined, in addition to the preparatory studies, in those alread pursued by the class they propose to enter. Any person admitte to this advanced standing, unless coming from another colleg pays the sum of ten dollars as tuition money for each term whi has been completed by the class which he enters. No one can b admitted as a candidate for a degree after the commencement the last year of the course. A graduating thesis is required at th close of this course from all candidates for the degree.

2. TO SPECIAL COURSES.

Students who are not candidates for a degree, and who propo to pursue some special department of study, are not required pass an examination for admission; but are expected to furnish th Professor with whom they are enrolled, satisfactory evidence their capacity to profit by the proposed instruction.

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* Playfair's Euclid is *not* accepted as an equivalent.

For pursuing special courses of study in the various branches of practical chemistry, including Metallurgy, the Analytical Laboratory affords convenient facilities. In Zoology also and other branches of natural history special students can be conveniently received. Instruction will likewise be given in Practical Astronomy and the use of the instruments. But there is no opportunity in this institution for young men to select, in an aimless manner, here a little and there a little, from the instructions which are provided. Those who determine to pursue the Select Course, laid down in the programme, are expected to give their attention to all its studies.

3. TO HIGHER COURSES, AS CANDIDATES FOR THE DOCTORATE OF PHILOSOPHY.

Graduates of this or of other colleges who may desire to receive the degree of Doctor of Philosophy, are required to remain in New Haven, during at least two academic years after receiving their first degree, during which they must engage faithfully in a course of study selected, with the approval of the Faculty, from branches pursued in the department of Philosophy and the Arts. The selection may be made from the studies of either or both Sections, but must belong to at least two distinct departments of learning. At the close of the course the candidate must pass a satisfactory examination, and present a thesis giving evidence of high attainment in the studies to which he has attended.

All persons, who have not previously received a degree furnishing evidence of acquaintance with the Latin and Greek languages, will be reqnired, before presenting themselves for the final examination for the Doctor's degree, to pass a satisfactory examination in these languages, or in such other studies (not included in their advanced course) as shall be accepted as an equivalent by the Faculty.

Time of Admission.

The regular examinations for admission to the Scientific School take place at Sheffield Hall, on the Tuesday preceding "Commencement," at 9 o'clock, A. M., and eight weeks later, on that Wednesday in September on which the fall term begins—that is, in 1868, July 21 and Sept. 16. Opportunity for private examination may, in exceptional cases only, be given at other times.

Terms and Vacations.

The College "Commencement" is held on the last Thursday bu one in July of each year. The first term begins eight weeks fro the day before Commencement and continues fourteen weeks; th second begins on the first Wednesday in January and continue fourteen weeks; the third, of twelve weeks, begins, this Collegiat year, on the last Wednesday in April and continues till Con mencement. The intervening periods, of eight, two, and tw weeks, are assigned for vacations.

The graduating exercises of the Scientific School take place o the Monday (July 20, 1868) before the public Commencement.

Tuition.

The charge for tuition is $125 per year, payable $45 at the b ginning of the first and of the second term, and $35 at the begi ning of the third term. The special student of Chemistry als pays the additional charge of seventy-five dollars per annum f chemicals, and for use of apparatus. He will also supply himse at his own expense with gas, flasks, crucibles, &c., the cost which should not exceed five or ten dollars per term.

The fee for graduation as Bachelor of Philosophy, including th charges for Triennial Catalogues, College Dinners, etc., is te dollars.

Lectures.

Annual courses of lectures are given on the following topics:

FIRST TERM.

On Metallurgy, by Prof. BRUSH.
On Mining, by Prof. ROCKWELL.
On Practical Agriculture, by Prof. BREWER.
On Agricultural Chemistry and Physiology, by Prof. JOHNSON.
On the History of Language and Linguistic Ethnology, by Prof. WHITNEY.
On Entomology, by Prof. VERRILL.

SECOND TERM.

On the Strength of Materials, by Prof. NORTON.
On Metallurgy (continued), by Prof. BRUSH.
On Mining (continued), by Prof. ROCKWELL.
On Practical Agriculture (continued), by Prof. BREWER.
On Agricultural Chemistry and Physiology (continued), by Prof. JOHNSON.
On Botany, by Prof. EATON.
On Structural and Systematic Zoology, by Prof. VERRILL.

On the History of Language and Linguistic Ethnology (continued), by Prof. WHITNEY.
On Physical Geography, by Prof. GILMAN.
On Military Science and Tactics, by Gen. A. VON STEINWEHR.
On the Principles of Mechanism, by Prof. LYMAN.

THIRD TERM.

On Systematic Mineralogy, by Prof. BRUSH.
On Economic Mineralogy and Petrology, by Prof. BRUSH.
On Rural Economy and Farm Management, by Prof. BREWER.
On Structural and Systematic Zoology (continued), by Prof. VERRILL.
On the Steam Engine, by Prof. LYMAN.

Examinations.

Oral examinations are held at the close of every term on the studies of the term, and written examinations are held every year on the studies of the year.

COURSES OF STUDY.

FOR THE DEGREE OF BACHELOR OF PHILOSOPHY.

All who are candidates for the degree of Bachelor of Philosophy are expected to pass through the same course of instruction in the first year of their connection with the institution, unless they are admitted on examination to an advanced standing. The studies of Freshman year are those which are regarded as an important basis for all the higher instructions of the school. This introductory course includes a continuance of the mathematical studies required for admission, the general elements of Chemistry and Physics, the commencement of German, practice in English composition and Elocution, Surveying and Drawing,—as will be seen in the following outline. Near the close of Freshman year, every student is required to announce his selection of one of the seven higher courses of study,—and he is not allowed to change after the beginning of the second or Junior year without permission specially granted by the Governing Board.

Freshman Year.

INTRODUCTORY TO ALL THE SECTIONS OF THE SCHOOL.

FIRST TERM.

Mathematics—Davies's Analytical Geometry. Spherical Trigonometry. Surveying. *Physics*—Silliman's Principles. *English Language*—Exercises in Composition. *Chemistry*—Recitations and Lectures. *German*—Woodbury's Method and Reader.

SECOND TERM.

English—Rhetoric. Practical Exercises in Elocution. *German*—Woodbury continued. Selections from approved authors. *Physics*—Silliman's Principles and Academical Lectures. *Chemistry*—Recitations and Lectures. *Mathematics*—Descriptive Geometry and Geometrical Drawing.

THIRD TERM.

English—Exercises in Composition. *German*—Selections. *Physics*—Silliman's Principles and Academical Lectures. *Chemistry*. *Mathematics*—Principles of Perspective. *Botany*—Gray's Manual. *Drawing*—Free Hand practice.

Junior and Senior Years.

During the last two years of the course the students are instructed in separate sections, the particular arrangements of which may be found below. Each section is under the charge of special professors, with the exception of the Select Course, which is under the general charge of the Governing Board. To a considerable extent the students of the several sections recite together. The study of French is commenced in the Junior year, and is required of all the students.

I. CHEMISTRY AND MINERALOGY.

[Under the direction of Professors JOHNSON and BRUSH; Chemical Laboratory, Sheffield Hall, West Wing.]

The Sheffield Laboratory is fitted up in a complete and convenient manner, is provided with all the requisite apparatus and instruments of research, possesses a considerable collection of chemical preparations, and a consulting Library of the best treatises on Chemistry and the Chemical arts. It affords facilities for instruction in the various branches of theoretical and practical Chemistry.

Theoretical and Descriptive Chemistry are taught throughout the whole of the Junior year by lectures and by recitation,—Eliot and Storer's Manual and Miller's Elements being employed as text-books. The lectures of Professor Silliman to the Academical and Medical Classes are also accessible to the Senior students. Every autumn term a class recites from Fresenius's Qualitative Analysis. Extended courses of Lectures on Agricultural and Metallurgical Chemistry are given yearly.

Mineralogy is taught in the Junior Year by lectures, which are *fully illustrated* with hand specimens and models, and by weekly

exercises throughout the Senior Year in the identification of minerals from physical and chemical characters.

The Laboratory is open for Chemical Practice seven hours daily, except on Saturday, when it is closed in the afternoon. The student repeats a large number of experiments from Eliot and Storer's Manual, and works through a course of qualitative and quantitative analysis, which is varied according to his capacity and the object he has in view. Each pupil proceeds by himself independently of the others, under the constant guidance of the Instructors.

In connection with the department of Mining and Metallurgy, especial attention is given to assaying and the investigation of ores and furnace products. The student in Agriculture has opportunity to acquaint himself with the modes of research employed in agricultural chemistry. The applications of the science to other branches of industry are taught as occasion requires.

The systematic course likewise includes instruction in Zoology, Botany, Geology, and the French and German languages, as will be seen from the following programme:

Freshman Year (see page 53).

Junior Year.

Inorganic Chemistry—Eliot & Storer's Manual, Recitations and Lectures. *Analytical Chemistry*—Fresenius. Recitations and Lectures. *Laboratory Practice*—Repetition of Experiments from Eliot & Storer's Manual. Systematic Qualitative Analysis. Use of the Blowpipe. Quantitative Analysis. *Mineralogy*—Dana's System, Lectures and Practical Exercises. *Botany*—Gray's Manual, Excursions and Preparation of Herbarium. *Zoology*—Lectures and Excursions. *French and German* (see Select Course).

Senior Year.

General Chemistry—Academical and Medical Lectures. *Agricultural Chemistry and Physiology*—Lectures. *Laboratory Practice*—Quantitative Mineral Analysis. Assaying. Organic Analysis. Special Investigations for Graduating Thesis. *Mineralogy*—Identification of Species. *Metallurgy*—Lectures. *Geology*—Dana's Manual. Recitations and Academical Lectures. *Human Anatomy and Physiology*—Academical Lectures. *Mechanics, Steam Engine, and other Prime Motors*—Lectures. *French* (see Select Course).

To advanced students, whether belonging to the regular classes or not, who desire to give attention to particular branches of chemistry, or to pursue original investigations, every facility is accorded.

The private libraries of the professors, containing the chemical journals and the recent *foreign literature* of chemistry and miner-

alogy, the large collections of ores, furnace products, &c., belong ing to the School, and the extensive private cabinet of the Profes sor of Mineralogy, are freely used as aids in instruction.

II. CIVIL ENGINEERING.

[Under the direction of Professor NORTON.]

The special course in Civil Engineering comprises theoretic and practical studies, and exercises in field operations and i drawing. It is designed, in connection with the studies of the fir year, to secure, in addition to a thorough mathematical trainin the knowledge of practical science essential to success in th profession of Engineering; and includes the careful study o the applications of Mathematics, Mechanics, Physics, Chemi try, &c., to Engineering, the use of Surveying and Engineerin Instruments, and an extended course of practice in Field oper tions and in Drawing. The student is also enabled to acquir a sufficient knowledge of French and German to make himse acquainted with professional works published in these languages.

The following is the programme of the course of study:

Freshman Year (see page 53).

Junior Year.

Mathematics—Descriptive Geometry, with applications. Shades, Shadows, an Linear Perspective. Analytical Geometry of three dimensions. Differential an Integral Calculus. *Astronomy*—Theoretical Astronomy. Practical Problem *French and German.* *Practical Surveying*—Triangulation, Survey of a Harbor, & Topographical Surveying. *Drawing*—Isometrical, Topographical, Mechanical.

Senior Year.

Mechanics—Theoretical Mechanics. Applications of Calculus to Mechanic Mechanics applied to Engineering. Principles of Mechanism. Thermodynamic Theory of Steam Engine. Prime Movers. *Civil Engineering*—Strength and Stif ness of Materials. Bridge Construction. Stability of Arches. Stone-cuttin with graphical problems. Constitution and properties of Building Material Civil Engineering proper, or the Science of Construction. *Geology.* *French*—S lections. *Field Engineering and Surveying*—Location of Roads. Laying o Curves. Geodesy. *Designing*—Designing of Bridges and other Structure *Drawing*—Architectural and Structural.

The Department is furnished with a full set of instruments fo Surveying and Field Engineering, and with a large collection o *illustrative* models.

HIGHER COURSE OF ENGINEERING.—The student in this department who, on the completion of the three years' course, has taken the degree of Bachelor of Philosophy, has the opportunity of pursuing a higher course, designed to give a special training, preparatory to professional practice. This includes, together with higher theoretical studies, Practical Astronomy, with exercises in astronomical observations with the Transit Instrument, Meridian Circle, Zenith Telescope and Sextant; and a course of exercises in the designing of structures. At the completion of this higher course the degree of Civil Engineer is conferred upon examination, and upon sufficient evidence being given of the ability of the student to design important structures, and make the requisite drawings, calculations, and estimates.

III. MECHANICAL ENGINEERING.

[Under the direction of Professor LYMAN.]

This section is closely connected with that of Civil Engineering, and many of the studies embraced in it are common to both. Prominence is necessarily given to the Mathematics and their applications, and to Mechanical Drawing, as lying, the one, at the foundation of all thorough theoretical training, the other, at that of professional practice. With these are joined other branches of science and modern languages, in order to secure both mental discipline and a better mastery of the special studies of the course.

The main object of the course is, by training the student in "such branches of learning as are related to the mechanic arts," to qualify him, as a mechanical engineer, for contributing toward the more efficient prosecution of these arts his services in the superintendence, construction, designing, or invention of machinery, in the management of mills or other mechanical works, or in the many other ways that lie within the scope of his profession.

It is not, of course, to be expected that the student will leave the institution with a full practical knowledge of the details of his professional work. The inculcation of the principles is the leading object. And yet, it is intended to bring the theory into as close relations with practice, as circumstances and the time allotted to the course will allow. To this end, practice in the use of tools is secured, for students needing it, in first-class machine shops in the

city, to such extent as may be required. There is, as yet, for want of the necessary means, no shop for mechanical practice connected with the School.

PROGRAMME OF STUDIES.

Freshman Year (see page 53).

Junior Year.

French and German (see Select Course). Descriptive Geometry with Applications. Analytical Geometry of Three Dimensions. Elementary Mechanics. Principles of Mechanism. Differential and Integral Calculus. Metallurgy. Shades, Shadows, and Linear Perspective. Isometrical Projection. Elements of Mechanical Drawing and Principles of Construction. Shading and Tinting, and drawing from patterns.

Senior Year.

French and German (see Select Course.) *Analytical Mechanics*—Strength of Materials. Thermo-dynamics. Theory and Construction of the Steam Engine. Prime Movers. Theory of Machines. Mill work. Examination of Machinery. Mechanical Construction. Machine-shop Practice. Architectural Drawing. Drawing from actual Machines. Designs of Machines.

IV. MINING AND METALLURGY.

[Under the direction of Professors BRUSH and ROCKWELL.]

Although this section of the school has been but recently organized, instruction preparatory to mining and metallurgical pursuits has been given in the school since 1857. The Freshman year is the same as in the other courses (see page 53). The Junior year is devoted to special subjects included under Engineering and Mechanics, to Geology, and the French and German languages. The Senior year is occupied with Mining and Metallurgy, and laboratory practice in Chemical Analysis, including Assaying, the determination of the character and value of ores and furnace products, and the discrimination of minerals. Drawing is continued through both years. The lectures on Mining will discuss in detail known facts in regard to Ore Deposits—strata, beds, veins or lodes, stockworks or other irregular masses; Dislocations—faults, and other irregularities; Methods of search; Boring of different kinds with the various apparatus; Tools used in various kinds of mining and in different countries; Blasting; Sinking of shafts; *Driving of* Levels and Galleries; Timbering, Masonry and Tub-

bing for securing underground openings; Exploitation, or the opening out of mines and the working away of veins and strata; Transportation underground; Winding or raising the minerals to the surface, and machinery and apparatus; Pumps and Pumping Engines; Ventilation, its principles and practice, natural and artificial, by furnaces and machines; Lighting—safety lamps; Mechanical Preparation of Ores, etc.

The lectures in Metallurgy will be divided into: (1.) *General Metallurgy*, including the physical and chemical properties of the metals and their ores, and of slags and other furnace products, the different methods used in both the dry and wet way in the extraction of metals; the character and effect of the different kinds of fuel; the materials employed in the construction of furnaces, crucibles, etc.; the details in regard to different forms of furnaces, blast, etc. Under (2) *Special Metallurgy*, each metal will be considered by itself, its physical and chemical characters given in detail, with the characteristics of its ores, the methods for their assay, and the metallurgical processes employed for the extraction of the metal or metallic compound.

In extension of the present course it is proposed to add at least one year for a higher course, analogous to the higher course in Civil Engineering; this will include four to six months' practice in the field in the study of mines and smelting works, to be followed by special Engineering or Chemical studies as applied to Mining and Metallurgy.

PROGRAMME OF STUDIES.

Freshman Year (see page 53).

Junior Year.

French and German (see Select Course). *Mechanics*—Peck's Elements. Principles of Mechanism. Theory of Steam Engine. *Mathematics*—Hydraulics *Civil Engineering*—Strength of Materials. Mining and Topographical Surveying. *Geology*—Dana. *Drawing*—Mechanical and Topographical.

Senior Year.

French (see Select Course). *Mining*—Lectures. *General and Special Metallurgy*—Lectures. *General Chemistry*—Miller. *Chemical Analysis*—Fresenius. Recitations and Lectures. *Laboratory Practice*—Qualitative and Quantitative Analysis. Use of the Blowpipe. Assaying. *Mineralogy*—Lectures and Practical Exercises. *Zoology*—Lectures. *Mechanics*—Application to Engineering. *Drawing.*

V. COURSE IN AGRICULTURE.

[Under the direction of Professors BREWER and JOHNSON.]

This course is intended to prepare the student for the successful management of a farm, by putting him in possession of a knowledge of the most approved methods of culture at present employed, and by explaining, so far as the state of learning admits, the reasons for these methods.

It is not expected to give a young man that familiarity with the mechanical operations of husbandry or that business capacity which is essential to the good farmer. These can only be acquired by assuming or sharing the care of a farm.

The course is in consequence adapted to those who are already familiar with rural affairs. Those who are practically ignorant of the varied details of farm practice can scarcely learn them thoroughly in an agricultural school, nor can they profit fully by the lessons proper to such an institution.

The main features of the course are, in addition to the mathematical and other studies of the first year, extended instruction by lecture in the Theory and Practice of Agriculture in all its branches; instruction in the French and German languages, in the accessory sciences, Chemistry, Botany, Zoology, Geology, Meteorology, and training in free-hand Drawing and experimental Chemistry.

Opportunities are offered for more particular attention to special branches, such as Horticulture, Forestry, &c., or to any of the sciences taught in the course, in their more detailed or specific applications.

In addition to the above brief programme, other topics of special interest and application in agricultural pursuits receive attention.

Excursions under the direction of the professors will teach the methods of out-door observation of natural objects, especially plants and insects useful or injurious to the farmer, as well as furnish illustrations of farming operations.

SHORTER COURSE.—For the accommodation of those who do not wish to pursue the entire course, the lectures are so arranged, that those upon the subjects of more immediate practical use, are delivered during the Fall and Winter terms. These embrace Agricultural Chemistry, Practical Agriculture, Stock Breeding and *Agricultural* Zoology. The lectures in the other departments are

also accessible to such students. Those who desire can thus attend during seven months of the year such a selection from the studies of the full course as will occupy their time profitably. For such admission to these lectures no examination is required, but testimonials of good character and the ability to profit by the instruction must be presented.

PROGRAMME OF STUDIES.

Freshman Year (see page 53).

Junior Year.

Agricultural Chemistry and Physiology—Structure and Physiology of Plants; Water, Atmosphere and Soil in their relations to Vegetable Production; Improvement of the Soil by Chemical and Mechanical means. Domestic Animals: the chemical relations of their Food, Digestion, Respiration, Assimilation and Excretion; Milk, Butter, Cheese, Flesh, and Wool as Agricultural products. Lectures. *Experimental and Analytical Chemistry*—Laboratory practice. *Meteorology*—Academical Lectures. *Physical Geography*—Lectures. *Zoology*—Lectures. *Drawing*—Free-hand practice. *French and German*—continued. *Excursions*—Botanical, Zoological, etc.

Senior Year.

Agriculture—The staple crops of the United States, their varieties, cultivation, management, and preparation for market. The Care, Breeding and Raising of Domestic Animals. Lectures and Recitations. *Experimental Chemistry*—Laboratory practice—*Agricultural Zoology*—Natural History of Domestic Animals; Insects useful and injurious to Vegetation. Lectures. *Human Anatomy and Physiology*—Lectures. *Geology*—Lectures and Recitations. *Rural Economy*, both American and foreign. Lectures. *French and German*—continued. *Excursions*—Botanical, Zoological, etc.

VI. COURSE IN NATURAL HISTORY AND GEOLOGY.

[Under the direction of Professors EATON, VERRILL and MARSH; Laboratory in Zoology, Trumbull Gallery.]

Students in this department, who are candidates for a degree, are required to complete the regular course of studies during the Freshman year. A knowledge of Latin and Greek is also very desirable.

Students not candidates for a degree may have special courses arranged for them by the Instructors from the studies of the Junior and Senior years, or additional thereto, if desirable.

The instruction in *Zoology includes*,

First—Courses of Lectures during the second and third ter the Junior year, on Structural and Systematic Zoology; during the first term of the Senior year, on general and ap Entomology and other special subjects, such as Embryo Geographical distribution, Nomenclature, &c.

Second—Direct practical instruction to special zoologica geological students, in the Zoological Laboratory, where the taught to prepare and arrange collections of various animal fossils, and by making critical identifications, to becom quainted with scientific literature, and to make dissectio studying comparative anatomy and embryology. They are when sufficiently advanced, encouraged to make original in gations. For these purposes specimens, both recent and f belonging to the College Museum, are made use of as ma required.

Third—Zoological Excursions in connection with the lec are instituted during the spring and autumn, to afford the stu opportunities to collect and observe the habits of both land marine animals, including those that live only in deep wate are obtained by dredging. By these excursions several tho specimens have been added to the College Museum during the two years, in addition to those retained by some of the stu for private collections.

PROGRAMME OF STUDIES.

Freshman Year (see page 53).

Junior Year.

FIRST TERM.

Zoology—Daily Laboratory instruction; Zoological Excursions. *Bo* Gray's First Lessons. *Chemistry*—Academical Lectures. *French and Ger* Selections.

SECOND TERM.

Zoology and Paleontology—Laboratory Practice, Lectures. *Physical Geo* —Lectures and Recitations. *Chemistry*—Laboratory Practice. *French an man*—continued.

THIRD TERM.

Zoology and Paleontology—Laboratory Practice, Lectures, Excursions (la marine). *Botany*—Gray's Manual; Excursions. *Mineralogy*—Dana, L and Practical Exercises. *French*—continued. *Drawing*—Free-hand Practi

Senior Year.

FIRST TERM.

Zoology and Paleontology—Laboratory Practice, Lectures, Excursions. *Geology*—Dana's Manual, Excursions. *Meteorology*—Academical Lectures. *French*—Selections.

SECOND TERM.

Zoology and Paleontology—continued. *Botany*—Lectures on special subjects. *Geology*—Dana, Recitations and Lectures. *Anatomy and Physiology*—Academical Lectures. *French*—Selections.

THIRD TERM.

Zoology and Paleontology—continued, with Excursions. *Photography*—Practical Instruction. *Preparation of Thesis. Examinations* in the studies of the course.

The Zoological and Geological Museum, which is accessible to all students, is already extensive, and amply sufficient to afford materials for the most advanced studies, as well as for the illustration of lectures.

The College Library, the Scientific School Library, and the private libraries of the Instructors contain a large number of works required for the more advanced studies in this Department, which students are allowed to use in the most liberal manner.

A large number of valuable diagrams have been prepared to illustrate the Zoological Lectures, and the microscopes and other instruments belonging to the Instructors are freely used for the same purpose.

The large private herbaria and botanical libraries belonging to the Instructors are open to the use of students, to whatever extent they may be needed, thus enabling the more advanced students to prosecute their studies to great advantage.

VII. SELECT COURSE IN SCIENCE AND LITERATURE.

[Under the direction of the Governing Board.]

The Select Course has been arranged to meet the wants of those young men who desire an education based chiefly on mathematical and physical science, and the modern languages, and who are not disposed to pursue either of the special courses already enumerated. The Freshman year is the same as in the other departments of the school. In the second and third years the scholars

are trained in a selection from the studies prescribed for the othe sections, and they also attend the lectures of President WOOLSE and some of the other instructors of the academi[redacted]department and recite in text-books which illustrate these lec[redacted]

As it is designed to make this course a valuab[redacted]eans of prepa ration for advanced scientific studies, it is hoped that especially the younger students who may avail themselves of its advantage will do so with the intention of going forward to pursue sti higher branches of learning. Students who enter upon the high studies taught in the school, having that acquaintance wi French and German, the mathematics, and the natural scienc which may be secured by an attendance upon the Select Cour will pursue their special professional studies with peculiar a vantages.

PROGRAMME OF STUDIES.

Freshman Year (see page 53).

Junior Year.

MODERN LANGUAGES.—*French and German*—continued. English Compositio and Literature.

MATHEMATICS.—Peck's Mechanics, Norton's Astronomy.

NATURAL SCIENCE.—*Agricultural Chemistry*—Lectures. *Zoology*—Lectures an Excursions. *Botany*—Lectures and Excursions. *Mineralogy*—Lectures. *Phys cal Geography*—Lectures and recitations.

HISTORY.—Recitations.

DRAWING.—Free-hand and Architectural.

Senior Year.

LANGUAGE.—*French or German*—continued. Lectures on Language and Li guistic Ethnology. Compositions.

NATURAL SCIENCE.—*Botany and Zoology*—continued. *Geology*—Recitatio and Lectures. *Meteorology*—Lectures. *Human Anatomy and Physiology*—Le tures. *Astronomy*—Lectures.

PHILOSOPHY AND HISTORY.—Lectures and recitations, in *History and Politic Philosophy, International Law, Political Economy, Ethics and Metaphysics.*

Preparation of a graduating thesis.

HIGHER AND PARTIAL COURSES.

Students are received to higher and partial courses by speci arrangement with the professors in the departments in which the are interested. (See pp. 50–51.)

FOURTH ANNUAL REPORT

OF THE

SHEFFIELD SCIENTIFIC SCHOOL

OF

YALE COLLEGE:

INCLUDING

I. THE REPORT OF THE VISITORS ON THE PART OF THE STATE OF CONNECTICUT;

II. THE REPORT OF THE GOVERNING BOARD AND FACULTY OF THE SCHOOL;

III. ROLL OF BENEFACTORS, STATE VISITORS, INSTRUCTORS, GRADUATES AND STUDENTS, SINCE 1846;

IV. A STATEMENT OF THE ESTABLISHED COURSES OF STUDY;

V. CATALOGUE OF THE ACTUAL OFFICERS AND STUDENTS.

1868-9.

NEW HAVEN:
PRINTED BY TUTTLE, MOREHOUSE & TAYLOR.
1869.

State Board of Visitors:

CONSTITUTING, WITH THE SECRETARY OF THE SCHOOL, THE BOARD FOR THE APPOINTMENT OF STATE STUDENTS.

May 1868 to May 1869.

GOVERNOR,

His Exc. JAMES E. ENGLISH, New Haven.

LIEUTENANT GOVERNOR,

His Honor EPHRAIM H. HYDE, Stafford.

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Hon. ISAAC T. ROGERS, Milford.
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SECRETARY OF THE STATE BOARD OF EDUCATION,

Rev. BIRDSEY G. NORTHROP, New Haven.

May 1869 to May 1870.

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SECRETARY OF THE STATE BOARD OF EDUCATION,

Rev. BIRDSEY G. NORTHROP, New Haven.

SECRETARY OF THE SHEFFIELD SCIENTIFIC SCHOOL,

Prof. DANIEL C. GILMAN, New Haven.

Corporation of Yale College.

April, 1869.

PRESIDENT,

Rev. THEODORE D. WOOLSEY, D.D., LL.D.

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His Exc. JAMES E. ENGLISH, New Haven.
His Honor EPHRAIM H. HYDE, Stafford.
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HENRY C. KINGSLEY, A.M.

TREASURER'S ASSISTANT,

LUCIUS W. FITCH, A.M.

FACULTY OF THE SHEFFIELD SCIENTIFIC SCHOOL.

(THE PROFESSORS IN THE SCIENTIFIC AND ACADEMICAL DEPARTMENTS OF YALE COLLEGE UNITEDLY CONSTITUTE THE "FACULTY OF PHILOSOPHY AND THE ARTS."

President,

REV. THEODORE D. WOOLSEY, D.D., LL.D.

Professors,

WILLIAM A. NORTON, M.A.,	*Civil Engineering and Mathematics.*
JAMES D. DANA, LL.D.,	*Geology and Mineralogy.*
BRIG. GEN. B. S. ROBERTS, U. S. A.,*	*Military Science.*
BENJAMIN SILLIMAN, M.D.,	*General Chemistry.*
REV. CHESTER S. LYMAN, M.A.,	*Industrial Mechanics and Physics.*
WILLIAM D. WHITNEY, LL.D.,	*Modern Languages and Linguistics.*
GEORGE J. BRUSH, M.A.,	*Mineralogy and Metallurgy.*
DANIEL C. GILMAN, M.A.,	*Physical Geography and History.*
SAMUEL W. JOHNSON, M.A.,	*Analytical and Agricultural Chemistry.*
WILLIAM H. BREWER, M.A.,	*Agriculture.*
———————	*Mining.*
DANIEL C. EATON, M.A.,	*Botany.*
OTHNIEL C. MARSH, M.A.,	*Palæontology.*
ADDISON E. VERRILL, M.A.,	*Zoölogy.*

Instructors,

MARK BAILEY, M.A.,	*Elocution.*
LOUIS BAIL,	*Drawing and Designing.*
DANIEL H. WELLS, C.E.,	*Mathematics.*
WILLIAM G. MIXTER, PH.B.,	*Chemistry.*
SIDNEY . SMITH, PH.B.,	*Zoölogy.*
EDWARD T. NELSON, B.A.,	*Mineralogy.*
HENRY S. WILLIAMS, PH.B.,	*Palæontology.*

*By appointment of the U. S. Government.

REPORT OF THE STATE BOARD OF VISITORS.

To the General Assembly of the State of Connecticut:

THE undersigned, in behalf of and by vote of the State Board of Visitors of the Sheffield Scientific School, would respectfully report that the Board have performed the duties required of them by law, in twice visiting the School during the year; once, for the purpose of examining the working management of the institution, and again, to select such applicants as presented themselves, with the proper qualifications, for the several gratuitous scholarships open to students from different parts of the State.

The management of the School during the year has been in the highest degree satisfactory to the Board of Visitors, and the instruction given in Agriculture, the Mechanic Arts, and the accessory branches of Science, of the most thorough and practically useful character.

The School with its able and efficient corps of instructors must continue to commend itself to public favor and confidence, as it is rapidly growing in the means of usefulness and enlarging its facilities for instruction.

The interesting and able report of the Governing Board and Faculty of the institution, which is herewith submitted, will

be found to contain all the necessary information desired with regard to the condition and management of the school and the course of instruction given therein.

The Board would avail themselves of this opportunity of commending the Institution anew not only to the approval and encouragement of the General Assembly, but to the confidence and patronage of the friends of education throughout the State.

JAMES E. ENGLISH,

Chairman.

New Haven, April 21, 1869.

A REPORT

RESPECTING THE PROGRESS OF

THE SHEFFIELD SCIENTIFIC SCHOOL

OF YALE COLLEGE,

Presented to the State Board of Visitors,

At their Annual Meeting, March, 1869,

BY THE

GOVERNING BOARD AND FACULTY OF THE INSTITUTION

Governing Board of the Sheffield Scientific School.

PRESIDENT WOOLSEY.

PROFESSORS DANA, NORTON, LYMAN, SILLIMAN, WHITNEY, BRUSH, GILMAN, JOHNSON, BREWER, EATON, MARSH, AND VERRILL.

Historical Note.

The Department of Philosophy and the Arts, to which the Scientific School pertains, was instituted in Yale College, at the Commencement of 1846. In 1860, Sheffield Hall, the gift of Mr. JOSEPH E. SHEFFIELD, of New Haven, was presented to the School, and immediately occupied. He also gave a fund of Fifty Thousand Dollars as the partial endowment of three professorships. In 1866, the Hall was enlarged and refitted a second time at the expense of the original benefactor.

The Congressional appropriation, made in 1862, for the establishment of a Scientific College, was directed to this institution by the General Assembly of 1863.

ANNUAL STATEMENT FOR 1868--9.

THE SHEFFIELD SCIENTIFIC SCHOOL of Yale College has now completed a fourth year since the congressional grant of 1862 was conferred upon it by the State of Connecticut. In the first of the annual reports required by the endowment-act of Congress, a brief historical statement was made respecting the growth of this institution from its origin in 1846; in the second, a survey was given of the scientific apparatus and collections here available to students; and in the third, there was a discussion of the ends of education, and of the means here employed for the attainment of those ends. A special feature in this report will be a Catalogue of the members of this department, from its beginning until now with a statement as full as we can make it of the various callings in life to which they are devoted. We shall also make as heretofore a statement of the progress of the school during the past year.

But before entering upon these topics it seems important, even at the risk of repeating what has been already said, to point out distinctly the position which is held by the Sheffield Scientific School in relation to the other departments of Yale College, and to the numerous Polytechnic, Technological, and Scientific Schools which are springing up all over the land. We are led to take this course by the fact that a year does not pass without our seeing that the work which we are trying to perform is quite imperfectly understood by the graduates and friends of Yale College, by many of the writers on the higher education, and by parents and teachers who are called upon to select for young men their advanced courses of study.

In respect to the other departments of Yale College the Scientific School has a two-fold parallelism. It is akin to the academic or classical department in the fact that it provides definite prescribed courses of study, continued through a term of years, rendered difficult and efficient by examinations at the outset, in the middle and at the close, and intended to secure to the student such a training of his faculties as will make him an intelligent, trust-

worthy, and useful man. Both the academic and scientific courses terminate properly in the Bachelor's degree conferred by the President and Fellows of Yale College, the one being a baccalaureate of "Arts" and the other of "Philosophy." The scientific course here pursued for three years is not a partial course or a modification of the classical curriculum, but it is as distinct and as complete in itself as if it were wholly disconnected with the academic department. In the latter, Greek, Latin and mathematics constitute the chief studies, with an introduction to natural, historical, political and moral science; in the other, the various departments of mathematical, physical and natural science, with French and German, constitute the chief studies, and there is also some recognition of historical and political science. The scientific courses allow a greater degree of choice than the academic, or rather it should be said that after a year of preparatory discipline, the scientific students are divided into several distinct sections according to their preference of different branches of study. There has never been and there is no reason why there should ever be any rivalry, jealousy, or controversy between these two departments. Each is designed to meet the wants of particular classes of students. The classical courses remain as vigorous as ever, more than ever attractive we may say for the culture of certain minds and for the preparation of students to pursue certain callings; the scientific courses are becoming more inviting to other minds as a means of culture and as a preparation for other walks in life. Both the classical and scientific courses being controlled by one Board of Trustees (though the immediate officers of instruction and government differ), all the means of instruction afforded by libraries, museums, reading-rooms, astronomical instruments, and the like, are freely open to both sets of students. Whatever may be the difficulties elsewhere, in New Haven the old education and the new are friendly sisters and not rivals. The professors of the academic and scientific departments unitedly constitute the "Faculty of Philosophy and the Arts."

But the Scientific School has also its analogies with the professional schools of law, medicine and theology. Like them it offers to graduates of the academic department, to graduates of other colleges, and to non-graduates who have independently fitted themselves for higher scientific research,—opportunities to pursue special investigations, for a longer or shorter time, either with reference to certain occupations, (as those of the Engineer, the Miner,

the Chemist, the Explorer, the Astronomer, the College Professor, the Editor); or with reference to a second scholastic degree, the Doctorate of Philosophy; or with reference simply to the acquisition of knowledge in some chosen field of research. While the number of such students is smaller than the number of those who are pursuing our undergraduate courses, they are nearly always scholars who add credit to the school and for whom we are desirous of providing in the freest spirit of a university, the utmost opportunities of investigation and culture.

We have still a few words to say in reference to the position which we desire this school to take among the other like schools of this country. To most of our students we cannot yet offer the freedom of a German university. They come to us with too little preparation, with too indefinite an appreciation of their wants, in short too young (though our youngest limit of admission is sixteen years), to be allowed to select entirely their own courses of study. We permit them to choose, after one year's residence, their section of the school; yet in that section the studies are not optional but are prescribed. On the other hand our requirements for admission are as high as the preparatory schools of the country will allow us to make them, and we rigidly insist that every candidate for admission shall fully come up to the requirements. We conceive that this scientific school, to be most serviceable to the State and to the country, should maintain a high grade of scholarship. We cannot expect to equal the special schools of agriculture in the very desirable work of training practical farmers, though we hope by the prosecution of the science of agriculture, and by the training of scientific professors and agriculturists to contribute to the progress of agriculture; and we cannot expect to train mechanics for manual dexterity as well as they can be trained in certain manufacturing shops or perhaps in special technical schools; but we can teach or at least aim to teach the principles of science, the laws of its application, the right methods of research, the exact habits of computation, analysis and observation, and a fundamental reverence for truth,—while at the same time we impart something of that literary culture which is essential to a liberal education. In a word, we desire to furnish a training of the mind equal to and corresponding with that which is imparted in good classical colleges, but the basis of our instructions is chiefly to be found in the works of the Creator and in the laws by which the universe is governed, neither the practical relations of such studies

nor the value of linguistic, historical and social science being overlooked or neglected. In the future as in the past opportunities will be here afforded for the training of young men in the modern scientific professions, chemistry, engineering, etc., but as the schools of science are developed in all the States of the Union, the Sheffield Scientific School will seek for a distinctive character not so much by offering peculiar attractions to farmers as a class, or to mechanics as a class, as by inviting students who wish to become scholars in science, well trained in the higher departments of investigation, able to stand unabashed by the side of scholars in letters; and we hope that the large collections of books and periodicals, of collections in natural history, mineralogy and geology, the chemical, physical and astronomical apparatus, and the many men connected as teachers and students with an old university, will invite to the scientific department of Yale College, as they have long attracted to the academic department, a goodly number of young men from Connecticut and a still larger number from other parts of the land.

We trust that these remarks will not be construed by any who are connected with other schools of science, as invidious or presuming. It must be obvious to them as it is to us that the true secret of success in the present eagerness to establish technological schools is to give to each establishment a definite and if possible a distinctive character. The funds at command, the requirements of the locality, and the nearness or remoteness of kindred institutions deserve consideration in determining what position to assume, what wants to supply. There is danger that more schools will be established than the country demands, and to avoid bringing the new education into disrepute it is important that shallow instructions should be avoided and that each institution should do its best in its own pre-determined sphere.

Importance of Increased Endowments.

In our last report we called attention to the great desirability of providing an increased endowment for this institution, so that the annual income might become adequate to the current expenses. The change which was made by the State of Connecticut in the investment of the national fund for promoting instruction in agriculture and the mechanics, though it may prove in the end an advantage, has temporarily lessened our resources. The original in-

vestment in U. S. ten-forty bonds bearing interest in gold at five per cent. was changed by the State for Connecticut Bonds bearing six per cent. interest in currency. Our income has consequently been seriously diminished. As a consequence of this the salaries of those professors who give their whole time to this institution will be cut down during the year to come from $2,300 to $2,000. This is certainly a very inadequate recompense for their services, if the latter be measured by the proposals which are constantly made to them to engage in other occupations or to connect themselves with kindred institutions in other parts of the country. It is the personal interest of the professors in this particular foundation which has kept them here, and the belief that in New Haven a vigorous college of science will in all time be required. We have, however, been compelled to part with the services of one of our associates for the simple reason that a kindred institution in another city could offer him a suitable salary for his services, which our resources did not permit us to pay. The chair of Mining, one of the most important in the school, is consequently vacant, and we cannot completely realize at present our hopes in respect to that section of the school.

To those who contemplate aiding the efforts which we are making to maintain a well organized school or college, we may say that funds which promote the teaching-force of the institution are especially welcome,—funds, we mean, which enable us to provide thorough and varied culture to the young men entrusted to our care. We have already constituted a General fund of the Scientific School which we should gladly see enlarged. The gifts of which it is composed are stated on another page. This fund is given unconditionally to promote the interests of the institution at the discretion of the authorities. But instances occur sometimes where the giver desires to promote some particular department of study, or some section of the school. We should be glad likewise to receive such contributions and to keep them distinct for the purpose of promoting any branch of study in which the giver is interested. For example, a fund for the promotion of Civil and Mechanical Engineering, bearing the donor's name, and directed toward the maintenance of a professorship and scholarships, the purchase of instruments, models and books, the bestowal of prizes, etc., would be very serviceable. In short, gifts of any amount, small or large, can be so directed as to advance particular objects, and also increase the teaching-force of the school.

The Principal Benefactions of the Year.*

The most important contribution to the resources of the school made within the year is a gift amounting to somewhat more than ten thousand dollars, for the purchase of apparatus, models, diagrams, etc., in the department of mechanics and physics. The nucleus of this fund was the munificent contribution of Five thousand dollars made by Mr. Maurice Dwight Collier, (a graduate of Yale College in 1866,) in the name of his deceased brother, Mr. Thomas Fassitt Collier, recently a student in the Sheffield School. This gift is directed to the purchase of apparatus, models and books in mechanical engineering, the branch of study to which the late Mr. Collier was especially devoted while a student in New Haven. When the donor learned that this money could be expended more advantageously in Europe than in this country he generously added to his gift the sum of $1,000, to enable Professor Chester S. Lyman, the chief instructor of his brother, to go abroad and make the appropriate selections.

The instructors feel that a more beautiful token of fraternal affection is rarely seen than in the memorial thus established of one who was beloved and honored while he was among us, and whose early death we deeply mourn.

A brief biographical sketch, and the resolutions of the Faculty upon the receipt of this gift, may fitly be recorded here:—

Thomas Fassitt Collier was the son of George Collier and was born in St. Louis, January 13, 1848. He graduated as a Bachelor of Arts in the Washington University of St. Louis in 1866, and in September following he entered the Sheffield Scientific School, where he remained until May, 1868, having selected Mechanical Engineering as his special pursuit. Ill-health compelled him to leave us at the date last named, and to undertake for the benefit of his health a journey across the continent with the hope of going on to China. He had reached the neighborhood of Salt Lake City when he was taken sick and after a short illness he died, July 14, 1868, at the age of twenty years.

Regarding a career so early terminated there is little to say, except to lament the disappointment of such fond expectations as were centered upon our departed friend. He was a young man of excellent mental ability, unsullied character, and high aspirations. Of commanding appearance, of gentle demeanor, of amiable disposition, he was a favorite with all his comrades and he won the affectionate esteem of all his instructors. He showed great interest in the advancement of the higher education, and having inherited ample means, he took pleasure in contributing to the endowment of his Alma Mater in St. Louis and in planning for the future benefit of the institution in which he was receiving his professional training.

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* *This paragraph* was modified after it was presented to the Board of Visitors so *as to include some* additional gifts.

The following resolutions were adopted by the Governing Board in respect to the Collier Memorial:—

RESOLUTIONS.

Resolved, That this Board present their grateful acknowledgments to Mr. Maurice Dwight Collier for his generous gift of Five thousand dollars for the purchase of apparatus and books in the department of Mechanical Engineering.

Resolved, That in accordance with the expressed wishes of the Donor this gift be accepted and regarded as a memorial of his deceased brother, Mr. Thomas Fassitt Collier, of St. Louis, who was for nearly two years prior to his death a student in Mechanical Engineering in this institution.

Resolved, That all purchases made with this benefaction be marked with a distinctive label indicative of its memorial character.

In accordance with the proposals of Mr. Collier, Professor Lyman sailed for Europe, April 14, 1869, in company with Prof. H. A. Newton, of the academical department.

Just previous to his departure an informal meeting of some of the friends of the school was held in the library-room to listen to a statement of his proposed tour, and to learn what sort of purchases he desired to make. Shortly after this interview, several gentlemen in New Haven expressed their readiness to contribute an additional sum for the purchase of apparatus. Mr. Joseph E. Sheffield handed to Mr. Lyman, a letter authorizing him to expend ten thousand francs in Paris ($2,700). Mr. Henry Farnam added a check for $1,000, and four other gentlemen, Messrs. Eli W. and John A. Blake, Professor E. E. Salisbury, and Messrs. Alfred Walker & Co., unitedly contributed the sum of $375. These gifts, as generous as they were spontaneous, will enrich the school with what it has always stood in need of, a good collection of apparatus and models in physics and mechanics.

Within the year we have also received as a contribution to our General Fund the sum of One thousand dollars which was generously given by His Excellency Gov. James E. English.

Several generous gifts for special objects have also been received since the last report. A gentleman who was apprehensive that our limited resources might oblige us to omit the collation which has commonly followed the exercises of the graduating class, handed us a check to defray the cost of the anniversary entertainment. From one of the clubs maintained by the students (the Sigma Delta Chi), we received a gift of fifty dollars to be expended in two prizes; from a friend of the school who does not wish his name to

be mentioned, we received a gift of sixty dollars to be also devoted to prizes; and from another friend who has done us many other good services, we received a gift of one hundred dollars likewise for prizes, with the intimation that the gift would be annual; and finally from Mr. Charles Z. Brown of Poughkeepsie, N. Y., we received a gift of twenty-five dollars to be bestowed as a prize upon the best scholar in the select course.

The gifts made to the various cabinets will be referred to under their appropriate heads.

Courses of Study.

The courses of study remain very much as they have been during the last three years. It deserves to be mentioned however that the instruction of the Freshman class in chemistry was modified with very satisfactory results in the winter of 1867–8. Every member of the class, in addition to his attendance upon the recitations, is now permitted and required to attend upon practical exercises in the Chemical Laboratory, under the direction of the professors of chemistry and agriculture. He thus becomes familiar with materials and processes of which he reads, and he practices his eye and hand in the elements of chemical analysis. This method of instruction has been very satisfactory both to teachers and pupils.

A large room in the basement, furnished with tools, benches, engine lathe, and other appliances for working in wood and metal, affords facilities to special students for practice in mechanical construction. One of the students (a member of the Freshman class), has lately completed an excellent refracting telescope of two and a half inches aperture, object-glass, eye-pieces and brass mounting included. This collection of tools, etc., belongs to one of the professors; the institution having heretofore had no funds that could be appropriated to the very desirable object of providing more ample facilities for mechanical practice.

We have already said that by lack of funds for the maintenance of his professorship, the college has lost the services of Gen. A. P. Rockwell, who had been appointed a Professor of Mining. At the time of his coming here, we were not without hopes that our means would be so enlarged that we could retain his aid, and we are yet hopeful that the department of Mining will not fall behind the other departments of the school; but for the time being we cannot wonder that our associate has accepted an endowed professorship in another institution.

ure it is proposed to make the course in mining supple-
:o that in civil engineering or that in chemistry, and it is
e that the Corporation will be requested to make the de-
Mining Engineer, like that of Civil Engineer, depend upon
pletion of a four years course.

e appointment of the United States Government, Brig.
S. Roberts, U. S. A., has been detailed in accordance with
f Congress to give instruction in military science to the
of this department, and he entered upon the duties of this
nent in September last, at the beginning of the present
c year.

overning Board are very seriously considering the exten-
a period of four years, instread of three, of all courses
ad to the Bachelor's degree. By such a modification a
nplete education would be given to our students; the sci-
ourse would seem and would be more nearly parallel to the
course; and we should feel that the graduates of this de-
t went forth better fitted for their special callings as well
disciplined in their intellectual powers. It is only the
unds which prevents the immediate realization of this pro-

Public Lectures.

urth course of annual public evening lectures was given
he winter of 1868–9, according to the annexed programme.
ndance has continued good and an additional interest has
akened in the lectures by the voluntary publication of re-
them in the three daily newspapers of New Haven. A
ig incident occurred in connection with the sale of tickets
ginning of the lectures. In one manufacturing establish-
ne, (that of Messrs. J. B. Sargent & Co.), forty-six tickets
posed of,—a good indication of the intelligence of the
re employed. Nearly as many tickets were disposed of
eding year in the same establishment.

PROGRAMME.

lay,	Feb. 8.	Coal as a raw material.....	Prof. Brewer.
sday,	" 11.	Our National Domain, and how we got it,	" Gilman.
lay,	" 15.	Seeds, their vitality and distribution,....	" Eaton.
sday,	" 18.	Time, and Time Keepers,.....	" Lyman.
lay,	" 22.	Principles of Perspective,.....	" Bail.
sday,	" 25.	Volcanoes and Earthquakes, ...	" Marsh.

VII.	Monday, Mar. 1.	Oysters, and Oyster Culture,	Prof. Verrill.
VIII.	Thursday, " 4.	Metallurgy of Silver,	" Brush.
IX.	Monday, " 8.	Principles of Framing,	" Wells.
X.	Thursday, " 11.	Lobsters, their Structure and Habits,	" Smith.
XI.	Monday, " 15.	Sulphur,	" Brewer.
XII.	Thursday, " 18.	Sulphurous Acid and its Uses,	" Johnson.

The students of this department have also been favored with several "Sunday Evening Lectures," the attendance upon which, though entirely voluntary, has been so constant as to show an appreciation on the part of the young men of the attempt thus made to instruct them.

President Woolsey opened the course at the beginning of the academic year, and he was followed by Professor O. E. Daggett, (the College Pastor), Dr. Charles L. Ives, and several other gentlemen. The thanks of the school are particularly due to Rev. E. F. Burr, D.D., of Lyme, author of "Ecce Cœlum, or Parish Astronomy," for a course of ten lectures delivered on Saturday and Sunday evenings. To this last mentioned series of lectures the public were admitted.

At the meeting of the Connecticut Board of Agriculture held at Bridgeport, Jan. 12, 13 and 14, 1869, Professor Johnson gave two lectures on "The nutritive value of grasses and green fodder, as indicated by chemical analysis and feeding trials;" and Professor Brewer gave a lecture on "Feeding Stock, Green and Dry Fodder."

Professors Brewer and Gilman have also given frequent lectures before the Teachers' Institutes assembled in different towns under the direction of the Secretary of the State Board of Education.

The use of the main lecture-room was granted to Rev. B. G. Northrop, Secretary of the State Board of Education, for the purpose of holding a series of Teachers Institutes; and also to Dr. Lemercier, of Paris, for the purpose of exhibiting and explaining the elastic models in human and comparative anatomy, etc., manufactured by M. Auzoux.

The Connecticut Academy has held its monthly meetings in the library room, and the American Oriental Society held there its semi-annual meeting in October.

Time for the City.

Through connections effected by Mr. J. M. Fairchild, superintendent of the City Fire Alarm Telegraph, the striking of the *tower clock* of the School is repeated simultaneously on three

bells, one in the City Hall, one at his office, and one at Brown's jewelry store. The striking of nine at night on the bell of the City Hall, and the one stroke at noon, are thus made to mark very closely true New Haven mean time,—the error of the clock (first stroke of the bell) never being allowed to exceed ten seconds, unless very rarely from stoppage by ice on the hands. Mr. Fairchild proposes to transmit correct time, in the same way, to factories and other establishments in the city.

ADDITIONS TO THE SCIENTIFIC COLLECTIONS.

The Collections in Mineralogy, Geology and Zoölogy, belonging to Yale College, are to be transferred to the "Peabody Museum of Natural History," when that building shall be erected. Meanwhile the professors in those departments, as will be seen by the following statements, are busily engaged in adding to the collections, and in cataloguing and arranging the specimens. A part of the minerals, fossils, corals, shells, etc., are arranged for public view in the "Cabinet of Yale College," on the college square; part of the collections in zoölogy and geology are in the laboratory in the basement of what was formerly known as the Trumbull Gallery; the collection of fossil foot-prints is mostly in the State House; and other portions are temporarily stored away in places inaccessible to the public; the metallurgical museum and Prof. Brush's private cabinet remain in Sheffield Hall; rooms have also been set apart in the Street Art Building for archæological and ethnological collections.

The following account of the growth of these collections during the past year belongs to the University as a whole; but it is given here in order to illustrate fully the opportunities for the study of Natural Science, which are provided in New Haven; and also to recognize the generous assistance of many collaborators in different parts of the country.

1. Zoological Department.

Prof. A. E. Verrill, Curator.

During the past year the increase in the Zoölogical collection has been much less than in the three preceding years. This has been due mainly to the fact that the funds at the disposal of the Curator, ($150 from the College and $450 from the Peabody Fund), have not been sufficient even to pay the general expenses incurred

in caring for the collections already on hand, thus preventing any efforts to extend the collections, which would involve additional expense.

A great amount of scientific work has, however, been expended on the collection, by cataloguing and classifying those portions that most needed such attention, in writing monographs of special groups, and in describing numerous new species and genera,—thus rendering the duplicates available for exchange. In this way Mr. S. I. Smith has put the Crustacea into excellent order and has monographed a part of the Decapods. Prof. Verrill has monographed the polyps and corals of the west coast of America, and described numerous new forms, in the Transactions of the Connecticut Academy and the Proceedings of the Boston Society of Natural History.

Among the most important collections received during the year is an extensive and very complete series of the Marine Animals of the Bay of Fundy, collected by the Curator and Mr. S. I. Smith, aided by Messrs. H. E. Webster and Geo. A. Jackson, of the Scientific School, during the summer vacation. This is probably the largest single collection that has been made on our northern coast, and includes many new and interesting forms.

Dr. J. C. Winslow has sent a large and valuable lot of Unionidæ from Illinois, and has made an extensive collection of Insects. Mr. R. E. C. Stearns has contributed valuable collections of Crustacea, Echinoderms, and corals from the Pacific, including several new species. Dr. Albert Kölliker has sent a fine series of mounted spicula of Gorgonidæ, etc., prepared from original specimens in various European museums, which are of great value in determining the species and genera in this difficult order. Capt. James Pedersen has contributed another large and very fine collection of shells, etc., from the Gulf of California. Prof. J. D. Dana has presented a large number of corals, mostly type specimens used by him in the preparation of his work on Zoöphytes.

Among the other more important collections are a valuable series of typical Hymenoptera from Edward Norton, Esq.; a collection of reptiles, etc., from Florida, given by Mr. Wm. E. Foster; and a large and valuable collection of shells and other marine animals from West Florida, collected and presented by Col. E. Jewett, who is at present engaged in making another collection in the same region; an excellent collection of fishes, shells, and other marine animals of Florida, from Wm. T. Coons, Esq.; a large and

fine skin of the white bear, obtained by Dr. Hall's arctic expedition, and presented by Hon. C. M. Ingersoll; and a valuable collection of shells, etc., presented by Mrs. E. H. Bishop.

LIST OF DONATIONS.

Prof. D. C. Eaton.—Insects, New Haven, 35 species; Vertebrata, 2 species, 87
Bay of Fundy Expedition (*A. E. Verrill, S. I. Smith, Geo. A. Jackson, H. E. Webster*).—Fishes, Insects, Crustacea, Worms, Mollusca, Radiata, Sponges, from Eastport, Me., and Bay of Fundy, 500 species, ... 25,500
Dr. J. C. Winslow, Danville, Ill.—Fresh-water shells (Unionidæ), ... 650
Prof. G. J. Brush.—Insects, New Haven, 3 species; spicula of Hyalonema, 4
Prof. H. A. Newton.—Insects, New Haven. 6 species, ... 7
W. R. Belknap (S. S. S.).—Insects, New Haven, 4 species; Insects, Kentucky, 3 species, ... 13
Henry Richards, Hillsboro, Ill.—Insects, Illinois, 1 species, ... 5
Mrs. L. H. Smith, Norway, Me.—Insects, Maine, 9 species, ... 9
T. S. Gold, West Cornwall.—Currant-worms, 1 species, ... 50
E. T. Nelson (S. S. S.).—Insects, New Haven, 34 species; Bat, 1 species, . 58
Prof. S. W. Johnson.—Lepidoptera, 2 species; Embryo mice, New Haven, 9
Mrs. M. A. Edwards, New Haven,—Samia Cecropia, ... 1
J. T. Whitmore.—Insects, New Haven, ... 11
Prof. O. C. Marsh.—Insects, 2 species; Head of Turtle; living Amblystoma mavortium, Lake Como, 7 specimens; bat; bones of bear, ... 13
Prof. O. C. Marsh and *A. E. Verrill.*—Skeleton of Horse; Fishes, Mollusca, Sponges, etc., Long Island Sound, 10 species, ... 65
Prof. L. R. Packard.—Insect and Crustacea, New Haven, ... 2
Thos. Bickford, Wallingford.—Bats, 2 species, ... 2
Miss H. L. Verrill.—Insects, New Haven, 12 species, ... 16
C. W. Chapman.—Insect and Shrew, New Haven; Echinus, California; 3 species, ... 3
J. C. Hersey (S. S. S.).—Insects and marine Invertebrata, New Haven, 51 species, ... 126
E. W. Johnson (S. S. S.).—Insects, Georgia, Rhode Island, Connecticut, 21 species; marine Invertebrata, New Haven, Block Island, Rhode Island, 40 species; Reptiles, Georgia, 3 species, ... 108
G. H. Perkins (S. S. S.).—Insects, Illinois, 13 species; Reptiles and Crustacea, Illinois, 8 species; Unionidæ, Illinois, 20 species; Mollusca, New Haven, 3 species; Crustacea, S. Carolina, New Haven, Massachusetts, 5 species; Worms, etc., New Haven and Staten Island, 4 species, ... 672
Prof. W. D. Whitney.—Bones and skeletons of Birds, 10 species; Heron, fresh; Bird's skins, European and American, 41 species, ... 60
Lieut. Chas. P. Miller, U. S. A.—Living Alligator, ... 1
C. H. Dwinelle (S. S. S.).—Insects, New York, ... 2
Wm. R. White (S. S. S.).—Miscellaneous, New Haven, 25 species, ... 40
L. S. Ferry, (S. S. S. 1868).—Skin of Lynx, Highlands, N. Y. 1
Dr. Lucius A. Thomas, New Haven.—Myriapod, ... 1
J. J. Skinner (S. S. S.).—Samia Cecropia, ... 1
Prof. A. Van Name.—Book-worms from Library, 1 species, 40 specimens; Crustacea, New Haven. 1 species, ... 52
Prof. A. E. Verrill.—Insects, New Haven, 16 species; marine Invertebrata, New Haven, 53 species; Bird skeletons, 2 species; Insects, Wisconsin, 10 species; Shells, West Indies, 6 species; Bats, New Haven, ... 371
S. I. Smith (S. S. S. 1867).—Insects, New Haven, 18 species, ... 24
Prof. B. Silliman.—Shell, Nicaragua, ... 1
Edward Norton (Y. C. 1844).—Farmington,—Shells, New Orleans, 2 species; European Galls, 16 species; typical Hymenoptera, 126 species, ... 377
Department of Agriculture.—Eggs of Silk-worm, Asia Minor, ... 200
J. T. Blackstone (S. S. 1868).—Miscellaneous, New Haven, 42 species, ... 126

Paul Roessler, New Haven.—Large Pearl from Oyster, ... 1
W. O. Atwater (S. S. S.).—Sphinx, New Haven, ... 1
J. C. Hornblower (S. S. S.).—Samia Cecropia, New Haven, ... 2
D. H. Wells (S. S. S. 1867).—Lepidoptera, New Haven, ... 2
Prof. W. H. Brewer.—Eacles imperialis, Cambridge, Mass., ... 1
Geo. A. Jackson (S. S. S. 1868).—Marine Invertebrata, New Haven, 22 species, ... 50
Wm. E. Foster (Y. C. 1860).—Mammals, Reptiles, Fishes, 21 species; Insects, 24 species; Crustacea, 6 species; Mollusca, etc., 11 species; all from Florida, ... 118
Prof. J. M. Hoppin.—Bones of Moose, Maine, ... 1
Prof. F. H. Bradley (Y. C. 1863).—Shells, East Indies, ... 2
A. Daggett, Jr., New Haven.—Shells, 9 species; Foraminifera, 2 species; Insects, 3 species. 22
J. Bradley, New Haven.—Ophiura, Long Island, ... 1
Prof. W. W. Daniels, Madison, Wis.—Insects from Wisconsin, 2 species, .. 2
Rev. John Dickinson, Westville.—Eugorgia Mexicana, Acapulco, ... 3
G. F. Matthew, St. John, N. B.—Land Shells from Cuba, 10 species, ... 75
Prof. J. D. Dana.—Corals, mostly original typical specimens, 205 species, . 210
J. T. Metcalf.—Shells, Nantucket, 1 species, ... 12
Capt. James Pedersen.—Mollusca, 200 species; Crustacea, 5 species; Echinoderms, 10 species; Corals, 5 species; Miscellaneous, 5 species; all from Gulf of California, ... 2214
William T. Coons.—Fishes and Reptiles, 32 species; Insects, 18 species; Crustacea, 36 species; Worms, 7 species; Mollusca, 70 species; Radiata, 16 species; all from West Coast of Florida, ... 611
Mrs. E. H. Bishop, New Haven.—Fishes, Shells, Echinoderms, Corals, Crustacea, Sponges, 326 species, ... 3616
Hon. Colin M. Ingersoll, New Haven.—Skin of white bear, ... 1
John G. Meirs.—Skeleton of mink, Hornerstown, N. J., ... 1

OBTAINED BY PURCHASE.

Prof. H. A. Ward, Rochester, N. Y.—Mounted skeletons of Mammals and Reptiles, 7 species; Bones of the legs of domestic animals, 5 species, ... 12
Charles G. Brewster, Boston.—Mounted skeletons and skulls, 6 species, ... 6

RECEIVED IN EXCHANGE.

Col. Ezekiel Jewett, Utica, N. Y.—Reptiles and Fishes, 27 species; Insects, 5 species; Crustacea and Worms, 23 species; Echinoderms and Polyps, 13 species; Mollusca, 167 species; all from Florida, ... 7216
Museum of Comparative Zoölogy.—Corals, 38 species; Land and Freshwater shells, Brazil, 50 species, ... 145
Robert E. C. Stearns.—Echinoderms, California, Japan, Aleutian Islands, etc., 12 species; Corals, California, 2 species; Crustacea, California, 15 species; Bryozoa, 4 species. 198
Rev. C. M. Jones, W. Madison.—Birds eggs, Virginia, 3 species, ... 6
Prof. James Orton.—Fishes, Insects, Crustacea, and Echinoderms, South America, 27 species, ... 33
Dr. Albert Kölliker, Wurzburg, Bavaria.—Microscopic preparations of spicula of Alcyonaria, deposited by A. E. Verrill, 83 species, ... 86
G. H. Perkins, (S. S. S.).—Radiata, 4 species; Crustacea, 3 species; Mollusca, 2 species, ... 23
Peabody Academy of Science, Salem, Mass.—Shells, San Salvador, 1 species, 3

COLLECTIONS SENT AWAY IN EXCHANGE.

University Zoölogical Museum, Copenhagen.—Polyps and Echinoderms, 149 species; Mollusca, 1 species, ... 341
J. Pedersen.—Mollusca from West Coast of America, 116 species, ... 145

Kölliker, Würzburg, Bavaria.—Alcyonaria, 4 species,	4
White, Iowa City, Iowa.—Radiata and Mollusca, 4 species,	39
ton, Farmington, Conn.—Mollusca, 10 species; Insects, 2	48
ckard, Jr., Salem, Mass.—Insects from New Haven, 4 species,	19
ns (S. S. S.).—Mollusca, 42 species,	191
ademy of Science, Salem, Mass.—Mollusca, 21 species; Crus- species; Worms, 1 species; Marine Invertebrates living, 20	219
ett, Utica, N. Y.—Mollusca, 198 species; Echinoderms, 28	361
lem, Mass.—Radiata, 4 species,	21
y Natural History.—Radiata, 10 species; Crustacea, 15 species,	50
f Wisconsin, Madison, Wis.—Radiata, 21 species; Crustacea, Mollusca, 1 species; Sponges, 1 species,	36
r, Union College, Schenectady, N. Y.—Crustacea, 13 species; species; Radiata, 26 species; Mollusca, 6 species,	110
w, Danville, Ill.—Mollusca, 100 species; Radiata, 28 species; 9 species; Sponges, 2 species,	263
um.—Alcyonarian Corals, 53 species,	79
ey for Packer Institute, Brooklyn, N. Y.—Shells, 50 species,	80
iety Natural History, Portland, Me.—Crustacea, 30 species; 60 species; Radiata, 20 species,	208

2. Geological Department.

Prof. O. C. Marsh, Curator.

ological museum of Yale College has received some very additions within the past year, more especially through and purchases. The work of cataloguing and re-arrang- rious collections has also been successfully continued by Williams, assistant in this department, and by Messrs. son and G. H. Perkins, special students.

st interesting and valuable gift is a slab of fossil foot- m the Connecticut valley, which the Class of 1868, in o an appeal from Prof. Marsh, presented to the Cabinet graduation as a parting memorial. This specimen was r Turner's Falls, Mass., about two years since, by T. M. , Esq., of Gill, Mass., and is undoubtedly the finest slab nts ever discovered. It is about 30 by 20 feet in size, and impressed upon it a continuous series of 21 tracks of the *Otozoum*, each track being upwards of 15 inches in length. also on the same surface quite a number of other kinds nts, many of them the so-called "bird-tracks," with some y made by crustaceans and insects, and over all the rain- essions of a slight shower. This fine specimen, which d by the owner at $1,000, will add greatly to the interest nological collection, for which a special suite of rooms rovided in the new Peabody Museum.

This liberality of the Senior Class of Yale College was ir mediately followed by the members of the graduating class of tl Sheffield Scientific School, who presented to the Cabinet anoth unique slab of fossil footprints from the same region. This spe men was recently found by Roswell Field, Esq., on his farm in Gi Mass., and was secured by the class at an expense of $200. It about 12 by 2½ feet in size, and has on its smooth surface a row five large tracks of *Brontozoum*, by far the most perfect series y discovered. By these farewell acts of generosity on the part the graduating classes, not only have very valuable acquisitio been secured for the museum of geology, but a movement of gre importance to the college has been inaugurated, which futu classes will doubtless esteem it a privilege to continue.

Noteworthy additions to the geological cabinet have also be received during the past year from the marl deposits of New Je sey. Most of these specimens were discovered while excavatir for the "marl," or greensand, which, on account of its fertilizir properties, has long proved of great value to agriculturists.

The most important of these acquisitions is a large and interes ing collection of cretaceous fossils from the middle marl bed, r cently presented to the College cabinet by John G. Meirs, Esq in behalf of the Cream Ridge Marl Company of Hornerstow N. J. This collection consists of about 500 specimens, includir many rare vertebrate remains, some of which are undescribed ar of peculiar interest. Several collections of fossils from tl same region have also been presented to the museum, the mo important of which are a fine suite of specimens lately received fro the West Jersey Marl Co., through the Superintendent, I. C. Voo hies, Esq.; and a valuable series from Birmingham, N. J., sent b J. C. Gaskill, Esq., Superintendent of the Pemberton Marl Co.

From the upper marl bed, or tertiary greensand, of New Jerse an interesting collection of vertebrate fossils has recently be received from O. B. Kinne, Esq., which forms an important add tion to his gift of the previous year. Wm. E. Barrett, Esq., tl present Superintendent of the Squankum Marl Company, has al presented to the museum a fine suite of fossils from the same loca ity. A valuable donation of specimens from Farmingdale, N. J has just been received from the Squankum and Freehold Ma Company, through the Superintendent, Major A. J. Smith.

The Smithsonian Institution has also presented to the Colleg Cabinet an interesting suite of fossil plants from Australia, co

lected by Prof. J. D. Dana; and a valuable gift of fossil fishes from the English Coal Measures has recently been received from T. P. Barkas, Esq., of Newcastle on Tyne.

DONATIONS RECEIVED DURING THE PAST YEAR.

Prof. James Orton, Rochester, N. Y.—Fossil shells from Peru, ... 12
Charles D. Marshall, Esq., Buffalo, N. Y.—Devonian fossils from Western New York, ... 10
E. U. Canfield, Esq., Colorado.—Fossil wood from near Pike's Peak, and Baculite from vicinity of Colorado City, ... 11
George Eastburn, (Y. C. 1868).—Fossil shells and coral from New Jersey, ... 3
Rev. R. E. Hawley, Cincinnati, O.—Silurian fossils from Ohio, and fossils and rocks from sub-carboniferous of Indiana, ... 36
Dr. A. M. Leonard, Lockport, N. Y.—Fossils from Niagara Group of Western N. Y., ... 20
Hon. J. V. Dickinson.—Cretaceous fossils from Woodstown, N. J., ... 23
Prof. C. U. Shepard, Jr., (Y. C. 1863).—Fossils from near Charleston, S. C., 6
Class of 1868, *Yale College.*—Slab of Connecticut River Sandstone with series of *Otozoum* footprints and other impressions from Turner's Falls, Mass., 1
Class of 1868, *Sheffield Scientific School.*—Slab of Connecticut River Sandstone with series of *Brontozoum* tracks, ... 1
C. A. Brinley (Sheffield S. S.).—Fossil bone from Connecticut River Sandstone at Manchester, Conn., ... 1
Col. E. Jewett, Utica, N. Y.—Vertebrate fossils and corals from near Tampa Bay, Florida, ... 7
Prof. G. F. Barker, (Yale College).—Oyster shells from shell deposit in Maine, 2
Geo. W. Miles, U. P. R. R.—Cretaceous fossils from Wyoming, ... 5
John Collett, Esq., Eugene, Ind.—Carboniferious fossils from Perryville, Ind., 3
Dr. Isaac Lea, Philadelphia.—Triassic fossils from Pa., ... 6
Charles M. Brewer, Esq.—Cretaceous fossils from Upper Freehold, N. J., ... 45
S. H. Brinley, Esq., Alexandersville, O.—Lower Silurian fossils from Ohio, .. 38
G. F. Matthew, Esq., St. John, N. B.—Cretaceous and Tertiary fossils from Cuba, 40
W. N. Longworth (Y. C., class 1844).—Devonian fossils from Kentucky, ... 30
Dr. P. J. Farnsworth, Clinton, Iowa.—Niagara and Hudson fossils from Iowa, 42
Charles D. Sherman, Esq.—Femur of Mastodon from Wyoming Territory, ... 1
Prof. A. M. Wheeler (Yale College).—Fossil fish from Lebach, Rhenish Bavaria, ... 1
Gen. W. B. Franklin.—Specimens from Artesian well in Hartford, Conn., ... 3
C. M. Wheatley, Esq.—Triassic fossils from Phœnixville, Pa., ... 10
George A. Jackson (Sheffield S. S. 1868).—Lower Helderberg fossils from Pembroke, Me., ... 2
Alexander Carter, Esq.—Fossils from Ashley River phosphate beds, S. C., ... 15
Erastus Brainard & Co.—Slab of Connecticut River Sandstone showing shrinkage cracks, Portland Ct., ... 1
Middlesex Quarry Co.—Block of Connecticut River Sandstone containing two fossil trees, ... 1
T. P. Barkas, Esq., Newcastle on Tyne, England.—Fossil fishes from British Coal measures, ... 50
Prof. O. C. Marsh (Yale College).—Tertiary and Cretaceous fossils from N. J.; Tertiary and Cretaceous fossils from Nebraska and Wyoming Territories; Silurian and Devonian fossils from New York; fossil footprints from Turner's Falls, Mass.: slab of *Protichnites Logananus*, from Potsdam sandstone, Port Kent, N. Y., ... 1750
Eugene Bristol (Sheffield S. S.).—Mastodon remains from Wyoming Territory, 20
Rev. S. W. Cowles.—Slab of sandstone with peculiar impressions, from near Salamanca, N. Y., ... 1
John Hogan, Esq., New Haven, Ct.—Fossils from Bitter Creek Divide, Wyoming Territory, ... 6

Prof. B. Silliman (Yale College).—Mastodon remains from drift of California; Fossils from Colorado, 20
William Barnes, Esq., Halifax, N. S.—Coal plants from Nova Scotia, 10
Cream Ridge Marl Co., Hornerstown, N. J.—Cretaceous fossils from Middle Marl bed, received through John G. Meirs, Esq., 500
Prof. W. M. Gabb, St. Domingo.—Fossil Unionidæ from near Camden, N. J., 20
John G. Meirs, Esq.—Cretaceous fossils from Upper Freehold, N. J., 150
Richard Wahl, Esq.—Fossils from Virginia, and Hornerstown, N. J., 10
Nicholas Wahl, Esq.—Fossils from Hornerstown, N. J., 15
Dr. F. V. Hayden.—Fossil Plants from Carbon Station, Wyoming Territory, 125
O. B. Kinne, Esq., New York.—Tertiary fossils from Upper Marl bed at Squankum, N. J., 1000
Wm. E. Barrett, Esq., Farmingdale, N. J.—Fossils from Pits of Squankum Marl Co., 75
J. C. Abney, Esq., Cheyenne, Wyoming.—Mastodon remains from Wyoming Territory, 15
Prof. B. F. Mudge, Manhattan, Kansas.—Tertiary plants and shells from Western Kansas, 30
Prof. J. D. Parker, Topeka, Kansas.—Fossils and rocks from Kansas, 10
C. B. Dyer Esq.—Lower Silurian fossils from Cincinnati, O., 30
Col. James Greer, Dayton, Ohio.—Fish remains from near Vicksburg, Miss., 10
Pemberton Marl Co.—Cretaceous fossils and marl from Birmingham, N. J., received through J. C. Gaskill, Esq., Superintendent, 125
J. H. Congdon, Esq., Omaha, Nebraska.—Tertiary fossils from Nebraska and Wyoming, 26
G. W Barnhart, Esq., U. P. R. R.—Tertiary fossils from Antelope, Nebraska. 75
Prof. F. H. Bradley (Y. C. 1863), Hanover College, Ind.—Silurian trilobites from Indiana, 3
William McCord (Y. C. 1862), Cheyenne.—Fossils from Wyoming, 3
Dr. P. D. Knieskern.—Tertiary fossils from Shark River, N. J., 40
Lucien Pomeroy, Esq., Wallingford, Ct.—*Lepidodendron* from near Allegheny City, Pa., 1
E. A. Strong, Esq., Grand Rapids, Mich.—Fossils from Marshall Group at Holland, Mich., 30
West Jersey Marl Co.—Cretaceous fossils from Marlboro, N. J., received through I. C. Voorhies, Esq., Superintendent, 140
Robert S. Van Rensselaer, Esq.—Cretaceous fossils from Marlboro, N. J., 70
Henry J. Irick, Esq.—Tertiary fossils from Vincentown, N. J., 2
Squankum and Freehold Marl Co—Tertiary fossils from Upper Marl bed, Farmingdale, N. J., received through Major A. J. Smith, Superintendent, 76
Smithsonian Institution.—Fossil plants from Australia collected by Prof. J. D. Dana, 40
Prof. Alpheus Hyatt, Salem, Mass.—Silurian fossils from New York, 10
George Shafto, Esq.—Tertiary fossils from Shrewsbury, N. J., 4
Charles J. Sheffield (S. S. S. 1868), Cleveland, O.—Fossils from Wyoming, 5
Prof. G. W. Taylor, Pulaski, N. Y.—Graptolites from near Albany, N. Y., 3
Mrs. S. B. Eaton, Hudson City, N. J.—Devonian Starfish from Hamilton, N. Y., 1
Lyceum Natural History, Mt. Holly, N. J.—Fossils from Cretaceous of N. J., 5
Prof. Joseph Leidy, Philadelphia.—Cretaceous and Tertiary fossils, 10
S. S. Lyon, Esq., Jeffersonville, Ind.—Sub-carboniferous fossils from Indiana and Kentucky, 1
Hugh Hurley, Esq, Shrewsbury, N. J.—Tertiary fossils from Shark River, N. J., 1
George D. Roseberry (S. S. S.)—Coal plants from Pottsville, Pa., 2
Austin Hurley, Esq.—Tertiary fossils from Shrewsbury, N. J.,
Rev. H. Herzer.—Fish remains from Devonian of Ohio,

COLLECTIONS OBTAINED BY PURCHASE.

George M. Kellogg, Esq.—Fossils from Waverly Sandstone, near Richfield, Summit Co., Ohio, 100
James E. Borden, Esq.—Fossils from Trenton Falls, N. Y., 3
O. C. Herbert, Esq.—Cretaceous fossils from Marlboro, Monmouth Co., N. J., 50
Prof. F. H. Bradley.—Fossils from Keokuk limestone at Crawfordsville, Ind., 250

C. C. Childs, Esq.—Fossils and rocks from near Dubuque, Iowa,..... 150
C. G. Brewster, Boston, Mass.—Fossils and rocks from various European localities, ... 42
A. C. Kline, Philadelphia.—European and American fossils,..... 75
Prof. H. A. Ward, Rochester, N. Y.—European fossils, mostly from England,. 60
S. S Strong. Esq.—Carboniferous fossils from Morris, Ill.,..... 200
T. M. Stoughton, Esq., Gill, Mass.—Fossil footprints from Turner's Falls, Mass., 15
R. Field, Esq.—Slab of footprints from Gill, Mass.,..... 1
O. H. Lebourveau, Esq.—Collection of footprints from Montague, Mass.,.... 10

3. Mineralogical Collection.

Prof. G. J. Brush, Curator.

The most noteworthy addition to the Mineral Cabinet has been a large increase in the number of specimens represented in the collection of meteorites. By exchange with the authorities of the British Museum, ten specimens representing some new localities have been obtained, and by purchase, eighteen specimens of meteoric iron and ten specimens of meteoric stones have been added to the collection. Besides these, ten specimens of meteoric iron and one meteoric stone have been presented to the collection by Prof. Silliman, Prof. J. Lawrence Smith, of Louisville, and the Curator. The whole collection now contains specimens from forty-six stone-falls, and fifty-seven localities of meteoric iron. A catalogue of these has been prepared and published during the year.

The collection of crystallized minerals has been enriched by the gift of a very valuable specimen of crystallized gold from A. B. Preston, Esq., of San Francisco, and a very remarkable specimen of the tellurid of gold and silver with native gold, from the Melones Mine, the gift of G. Stevenot, Esq., of San Francisco. The Curator has also purchased for the collection an interesting suite of crystallized gold in quartz, from the Santiam Mine in Oregon. Mr. A. H. Ewing, of the Senior Class, has given a fine specimen of native copper from Lake Superior, and other important additions have been made. In order to make this collection fully effective for the purposes of science, it should be thoroughly labelled and catalogued, an undertaking which will require a large amount of labor, and which is rendered more difficult from the fact that the catalogues of the early collections acquired by the College are imperfect and incomplete.

4. Mining and Metallurgical Museum.

The following gifts have been received from the parties whose names are specified in connection with each donation.

Jackson Iron Company through Mr. Brown, Agent.—A suite of pig-iron produced at the Fayette Furnace, Michigan.

Prof. A. P. Rockwell.—Specimens of coal from La Salle, Illinois.
Chas. J. Sheffield, Esq., Cleveland, Ohio.—Collection of coal from coal mines worked by Payne, Newton & Co., Ohio.
Shoenberger & Co., Pittsburgh, Pa.—Suite of specimens illustrative of the Ellershausen process for the production of wrought iron.
F. Miles, Esq., Salisbury, N. Y.—Pig of iron made in 1755 at the Mt. Riga furnace.
Prof. B. Silliman.—Suite of gold and silver ores from Central City and Georgetown, Colorado, with specimens of coal from Boulder Co., Colorado.
Ellsworth Daggett, Ph.B. (S. S. S. 1864).—Specimens of silver from the White Pine District, Nevada.
Prof. A. E. Verrill.—Suite of iron ores from the Adirondack Mines.
W. G. Mixter, Ph.B. (S. S. S. 1867).—Specimens of chilled iron.
Dr. T. S. Bell, Louisville, Ky.—Specimens of copper ore from Young Co., Texas.
J. S. Adam, (Sheffield Laboratory, 1867–9).—Specimens of earthy cobalt ore from Canaan, Conn.
F. D. Buck, (S. S. S. 1869).—Specimens of anthracite from Scranton, Pa.
J. P. Wetherill, C. E.—Suite of anthracites from the Schuylkill coal beds.

5. Museum of Archæology and Ethnology.

The general interest manifested in this department of the University by graduates and others since its establishment last year has demonstrated the desirableness of commencing such a museum in connection with the institution, and affords strong hopes that it may soon assume the proportions its importance clearly merits. The nucleus of the museum was a collection of antiquities from American and European localities presented by Prof. Marsh, and soon after the Art Council granted the use of rooms in the new Art Building for the accommodation of this and future acquisitions.

To bring this new department to the attention of the friends of the college, and the general public, a circular* stating the objects of the museum, and soliciting donations was prepared and extensively distributed. In response to this appeal a large number of interesting specimens have already been received, which are mentioned more particularly in the accompaning list of donations. Among the most valuable is a suite of very perfect specimens of pottery, and stone implements from a mound in Mississippi, presented by George W. Gould, Esq.; and a fine series of ancient vases mostly from Peru, given by Prof. Silliman. Several interesting collections of American antiquities have recently been offered to the museum at very reasonable prices, but as this department is at present entirely without resources, no purchases have as yet been made. Now that the sciences of Archaeology and Ethnology are receiving so much attention in Europe, and also in this country, and so many opportunities are offering of securing memorials of the early American races, it is very desirable that this new museum

* See Third Annual Report, p. 34.

of Yale should soon receive a permanent and adequate endowment.

Specimens intended for this department may be sent to the care of Prof. O. C. Marsh. If possible, the exact locality of each article should be given.

LIST OF DONATIONS.

Smithsonian Institution.—Weapons, clothing and ornaments of natives of N. W. Coast of America and Pacific islands, collected by the U. S. Exploring Expedition, ... 40

Prof. O. C. Marsh (Yale College).—Collection of American Indian relics; implements and pottery of the mound-builders; specimens from various European localities illustrating the stone and bronze ages, ... 500

Dr. A. M. Leonard, Lockport, N. Y.—Indian arrows from Tonawanda, N. Y., 15

George Haines, Esq., Medford, N. J.—Various Indian relics from New Jersey, 20

Prof. W. H. Brewer (Yale College).—Indian implements from Enfield, N. Y., 10

T. M. Stoughton, Esq., Gill, Mass.—Stone axes and arrow-heads from near Turner's Falls, Mass., ... 12

Miss Lucy Stoughton.—Indian relics from Gill, Mass., and Indian skull from Montague, Mass., ... 6

Prof. Noah Porter (Yale College).—Indian stone axe from Connecticut, ... 1

John G. Meirs, Esq., Hornerston, N. J.—Stone implements of various kinds from Monmouth Co., N. J., ... 25

Mrs. J. W. King, New Haven.—Indian tomahawk and knife from Fort Kearney, Nebraska, ... 2

Prof. B. Silliman (Yale College).—Mexican corn mill, and indian mortar and pestle from Catalina Is. Cal.; Indian skull and various other antiquities from shell deposit at Rincon, Cal.; ancient pottery from South America, ... 30

C. Bushnell, Esq., Centerbrook, Ct.—Indian knife and axe from Conn., ... 2

Pitts H. Burt, Esq., Cincinnati, Ohio.—Stone chisel and arrow-head from Ohio, 2

Capt. S. P. Crafts, New Haven.—Models of boats from East Indies, ... 10

George W. Gould. Esq., Lockport, N. Y.—Stone implements and articles of pottery from a mound near Warrenton, Miss. 75

Prof. B. F. Mudge, Manhattan, Kansas.—Skull of Kaw indian, ... 1

E. F. Rockwell, Esq., Statesville, N. C.—Quartz arrow-head, ... 1

Col. H. B. Carrington, U. S. A.—Bows, quiver and arrows of Sioux Indians, 45

J. H. Sternbergh, Esq., Panama.—Specimens of Chiriqui pottery, ... 8

G. M. Boardman, Esq., New York.—Large earthen vase from South America, 1

Hon. Josiah Quincy, Boston, Mass.—Indian beads and implements from Quincy, Mass. 5

Erastus Brainerd, Esq., Portland, Conn.—Stone axe and chisels from Portland, ... 4

Mrs. Horace Fassitt, Philadelphia.—Stone chisel from Canada West, ... 1

F. D. Kellogg, Esq., Fair Haven, Conn.—Skeletons of indians from Fair Haven, ... 2

John Weld, Esq, Fair Haven, Conn.—Stone implements from Fair Haven, .. 3

Dr. A. J. Comfort.—Indian pottery from near Fort Wadsworth, Dakota, ... 3

Joline B. Smith, Esq., New Haven.—Stone implement from the Pacific, ... 1

Hiram A. Barnes, Esq., Fair Haven, Conn.—Indian skeletons from Fair Haven, ... 3

Dr. P. D. Knieskern.—Stone axe and arrow-heads from Shark River, N. J., .. 3

Richard Wahl, Esq., Hornerstown, N. J.—Indian relics from New Jersey, ... 8

Prof. H. A. Ward, Rochester, N. Y.—Bronze celt from France, ... 1

Dr. Gouverneur Emerson, Philadelphia.—Human remains and cast of pipe from Indian grave in Delaware, ... 5

Nicholas Wahl, Esq.—Indian stone axes from Hornerstown, N. J., ... 4

Prof. S. W. Johnson (Yale College).—Part of indian soapstone kettle from Denmark, N. Y., ... 1

George W Perrigo, Esq., Lockport, N. Y.—Stone chisel from Saganaw, Mich., 1
Mrs. M. D. Evans, Birmingham, N. J.—Indian arrow-heads from N. J., 5
Prof. D. C. Gilman (Yale College).—Indian arrow and spear-heads from Norwich, Conn., 100
Peabody Academy of Science, Salem, Mass.—Collection of implements used by natives of Pacific Islands 11
Franklin Peale, Esq., Philadelphia.—Arrow-heads from Pennsylvania, 6
Rev. S. Lockwood, Keyport, N. J.—Cast of stone implement from N. J., 1
Prof. A. W. Wright (Williams College).—Arrow-heads from Cincinnati, Ohio, 2
Prof. E. Hitchcock, Amherst, Mass.—Photographs of Indian relics, 2
Prof. Joseph Leidy, Philadelphia.—Indian spear-head from Pennsylvania, 1
A. J. Hill, Esq, St. Paul, Min.—Photographs of antiquities and arrow-heads from Minnesota, 3
Henry Davis, Esq., McGregor, Iowa.—Indian stone implements from Iowa, 17
Prof. F. H. Bradley (Y. C. 1863).—Flint arrow-heads from Ohio, 3
Greville I. Chester Esq., England.—Ancient shell chisels from Barbadoes, 2
Henry Smith, Esq., Grasshopper Falls, Kansas.—Vertebrae pierced by arrows. Kansas, 3
Rev. E. O. Dunning, (Y. C. 1932).—Antiquities from S. E. Tennessee, 4
Robert E. Day, New Haven.—Indian stone chisel from Walnut Hills, Ohio, 1
Edward S. Smith, New Haven.—Indian stone axe from West Haven, 1
Henry S. Williams (Yale College).—Human and animal remains, pottery and stone implements from ancient shell deposits on St. John's River, Florida, 10

ANNIVERSARY EXERCISES, DEGREES, PRIZES, ETC.

The theses of the graduating class of 1868 were read in Sheffield Hall on Monday morning and evening, July 20, and on the Thursday following, at the Public Commencement of Yale College twenty-five candidates were admitted to the degree of Bachelor of Philosophy, and one to the degree of Civil Engineer. The following are the names of the candidates, with the subjects of their graduating theses:—

CIVIL ENGINEER.

DANIEL H. WELLS, Ph.B., Upper Aquebogue, N. Y. "Design of a Roof-Truss."

BACHELORS OF PHILOSOPHY,

WELLINGTON MILES ANDREW, (Mining Engineering,) Orange. "On the Electric Telegraph."

LEONARD STRONG AUSTIN, (Mechanical Engineering,) Stratford. "On Improvements in Lathes for working Metals."

GEORGE FRANKLIN BAILEY, (Civil Engineering,) Rutland, Vt. "On Improvement in River Navigation."

*SAMUEL ATKINS BARBOUR, (Civil Engineering,) Bristol. "On Suspension Bridges."

FREDERICK CONVERSE BEACH, (Select Course,) Stratford. "On some of the recent Applications of Photography."

JAMES DETRAFFORD BLACKSTONE, (Select Course,) Norwich. "On the English Revolution of 1868."

EUGENE STUART BRISTOL, (Chemistry,) New Haven. "On the Deposit of Spathic Iron at Roxbury, Conn."

ALBERT GARDINER CLARK, (Select Course,) Cincinnati O. "On the Influence of Florence upon Literature during the Fourteenth and Fifteenth Centuries."

*HENRY MARCHANT DUDLEY, (Select Course,) Whitinsville, Mass. "On the Marine Life of Long Island Sound."

*HENRY TURNER EDDY, B.A., (Civil Engineering,) North Bridgewater, Mass. "On Tunnelling."

BARTON DARLINGTON EVANS, (Select Course,) West Chester, Pa. "On the Struggle in the Netherlands; its influence on Anglican and American Liberty."

EDWARD FORSYTH FINNEY, (Civil Engineering,) St. Louis, Mo. "On Limes, Cements and Mortars."

FRANK MORTON GUTHRIE, (Select Course,) New York City. "On the Comparative Advantages of the Pacific and Trans-Continental Railroads."

JOHN COREY HERSEY, (Select Course,) Bridgeport. "On Petroleum."

GEORGE ANSON JACKSON, (Select Course,) North Adams, Mass. "On the destined Supremacy of the English Language."

*JOSEPH SCOTT MCKELL, (Select Course,) Chillicothe, O. "On Spectrum Analysis."

CHARLES KINNEY NEEDHAM, (Civil Engineering,) Louisville, Ky. "On the Laying out, Draining, and Paving of Streets in Cities."

FREDERICK GEORGE NOONAN, (Civil Engineering,) Milwaukee, Wis. "On the Introduction of China to the Western World."

*LYMAN BRADLEY PARSHALL, (Select Course,) Earmer Village, N. Y. "On the Present Rate of Wages, and its Moral Influence upon the Laborer."

*WILLIAM WALLACE REDFIELD, (Civil Engineering,) Philadelphia, Pa. "On the Supply of Water in some of the Cities of the United States."

ALEXANDER RENICK, (Select Course,) Chillicothe, O. "On the Disposal of our National Domain."

*JOSEPH PERKINS ROCKWELL, (Mining Engineering,) Norwich. "On the Bessemer Process in the Manufacture of Steel."

*LEWIS BRIDGE STONE, (Select Course,) New York City. "On the Ancient Mound Builders of America."

SAMUEL SWIFT, (Select Course,) Brooklyn, N. Y. "On Contagion."

HENRY SHALER WILLIAMS, (Natural History,) Ithaca, N. Y. "On the Educational Value of the Inductive Sciences."

At the same time three prizes of ten dollars each, in gold, offered by the Berzelius Society for the best essays written on subjects assigned by the professors, were awarded by the faculty to the persons below named:

*For the best English Composition, "On the various theories in respect to the origin of Language," to GEORGE A. JACKSON.

*For the best essay on a subject in Natural History, "The Recent and Extinct Fauna of New England," to HENRY S. WILLIAMS.

*For the best essay on a subject in Civil Engineering, "The recent improvements in the construction of Railways," to CHARLES K. NEEDHAM.

A part of these theses and the three prize essays were selected to be read before the President of the College, His Excellency the Governor, and other members of the Corporation, the Board of Visitors, the Benefactors, and the Faculty of the College, on Monday Evening. The asterisk (*) indicates those which were thus distinguished.

LIBRARY AND READING ROOM.

The following periodicals are now received in the reading room. Many similar journals, which might be looked for in this list, are

received in part by the Library of Yale College and in p
the Professors privately.

AMERICAN.

Title.	How received.
American Journal of Science and Arts.	By gift of the Editors.
Scientific American.	By subscription.
American Artisan.	"
American Rail Road Journal.	"
American Gas Light Journal.	"
American Journal of Mining.	"
American Journal of Pharmacy.	"
American Farmer.	By gift of Messrs. Silliman
Horticulturist.	By subscription.
American Agriculturist.	By gift of the Publisher
Journal of the N. Y. State Agricultural Society.	By gift of the Society.
American Journal of Horticulture.	By subscription.
New England Farmer.	"
Southern Planter.	By gift of the Publisher
Practical Entomologist.	By subscription.
California Mining and Scientific Press.	By gift of Prof. Brewer.
California Farmer.	By gift of the Editors.
Journal of the Franklin Institute.	By subscription.
American Naturalist.	"
Journal of Conchology.	"
Van Nostrand's American Jour. of Engineering.	By gift of Messrs. Silliman
Proceedings of the Boston Soc. of Nat. History.	By gift.
Transactions of the Connecticut Academy.	By gift of the Academy.
American Publishers' Circular.	By gift of the Publisher

BRITISH.

Practical Mechanic's Journal.	By subscription.
Engineer.	"
The Engineering.	"
Mining Journal.	"
Farmer's Magazine.	"
Gardeners' Chronicle.	"
Zoölogist.	"
Ibis.	"
Annals and Magazine of Natural History.	"
Monthly Notices of the Astronomical Society.	"
Journal of the Chemical Society.	"
Chemical News.	"
Mechanics' Magazine.	By gift of Messrs. Silliman
British Journal of Photography.	"
Ironmonger.	"
Journal of the Society of Arts.	"

CONTINENTAL.

Cosmos.	By gift of Messrs. Silliman
Le Monde.	"
Chemisches Central-Blatt.	By subscription.
Annales de Chimie et de Physique.	"
Zeitschrift für Chemie.	"
Zeitschrift der Oberschlesischen Gesellschaft.	"
Annalen der Landwirthschaft in Preussen.	"
Civilingenieur.	"
Polytechnisches Central-Blatt.	"
Technologiste.	"
Botanische Zeitung.	"
Hedwigia.	"
Zeitschrift für Wissenschaftliche Zoölogie.	"
Journal für Anthropologie.	"
Revue Universelle des Mines.	"
Journal de Agriculture Pratique.	"
Revue et Magazin de Zoölogie.	"
Annales des Ponts und Chaussées.	"
Moniteur de la Photographie.	By gift of Messrs. Silliman
Bulletin de la Société Chimique de Paris.	By subscription.

A PRELIMINARY

ROLL OF THE SHEFFIELD SCIENTIFIC SCHOOL.

1846-1869.

NOTICE.—The lists of students which are included in this preliminary Roll are necessarily imperfect so far as occupations, titles, and residences are concerned. It is proposed to reprint the lists at an early day and every one who can aid in perfecting them is earnestly requested to communicate with the Secretary of the School, or with some other member of the Faculty.

I. BENEFACTORS,

Including those who have contributed at one time the amount of $100 and upwards.

JOSEPH E. SHEFFIELD, New Haven, the building known as "Sheffield Hall," twice enlarged and refitted; a fund of $50,000 for professorships; a fund of $10,000 for a library; a collection of models in engineering and architecture; an equatorial telescope and a meridian circle, and other gifts; total, $164,000.

THE GOVERNMENT OF THE UNITED STATES, through the Connecticut Legislature, May Session, 1863, the income from a fund of $135,000, derived from the sale of land-scrip.

GEORGE PEABODY, London, the sum of $150,000 to found "in connection with Yale College," a Museum of Natural History. (This gift is to constitute a distinct department of the College, but it is so closely allied to the objects of the Scientific School, as to require grateful recognition here).

JOHN T. NORTON, Farmington, the income for five years of the sum of $5,000.

JOHN P. NORTON, Yale College, (by bequest) books and apparatus valued at $2,500.

SUBSCRIPTIONS TO THE GENERAL FUND.

Oliver F. Winchester,	$5,000
Jeremiah Day,	1,000
Joseph Battell,	1,000
Eli Whitney,	1,000
Augustus R. Street,	1,000
Samuel Russell,	1,000
Pelatiah Perit,	1,000
Joseph Sampson,	1,000
James E. English,	1,000
Wells Southworth,	1,000
William Bostwick,	500
William & E. T. Fitch,	500
Morris Tyler,	300
William H. Elliot,	300
	$15,600

GIFTS FOR THE COMMENCEMENT OF A LIBRARY.

William W. Boardman,	$250
Jarvis Brush,	100
Tredwell Ketcham,	500
Perkins & Chatfield,	200
Joseph Sampson,	500
Henry Trowbridge,	100
Harmanus M. Welch,	100
John D. Wheeler,	250
	$2,000

GIFT FOR THE AGRICULTURAL MUSEUM.

Robert Benner,	$300

GIFT FOR THE MINING AND METALLURGICAL MUSEUM.

James D. Dana,	$500

GIFTS FOR PRIZES.

The Berzelius Trust Association, (in gold),	$170
Benjamin Silliman, (in gold),	50
The Sigma Delta Chi Society,	50
A friend,	100
A friend,	60
Charles Z. Brown,	25

GIFTS FOR THE PURCHASE OF APPARATUS AND MODELS IN MECHANICS, PHYSICS, E

Maurice D. Collier, in memory of the late Thomas Fassitt Collier,	$6,
Joseph E. Sheffield, 10,000 francs (in gold) equivalent to	2,
Henry Farnam,	1,
Edward E. Salisbury,	
John A. Blake,	
Eli W. Blake,	
Alfred Walker & Co.,	

In the foregoing list, the chief gifts in money are alone record
The principal gifts of specimens, models, etc., have been ackno
edged in the successive annual reports.

II. BOARD OF STATE VISITORS.

1864–5.

His Exc. Wm. A. Buckingham, Norwich.
His Hon. Roger Averill, Danbury.
Hon. Green Kendrick, Waterbury.
Hon. Ammi Giddings, Plymouth.
Hon. Daniel Chadwick, Lyme.
Hon. David N. Camp, New Britain.

1865–6.

His Exc. Wm. A. Buckingham, Norwich.
His Hon. Roger Averill, Danbury.
Hon. Edward I. Sanford, New Haven.
Hon. Orlando T. Hodge, Robertsville.
Hon. Charles A. Atkins, Mansfield.
Prof. Daniel C. Gilman, New Haven.

1866–7.

His Exc. Joseph R. Hawley, Hartford. Hon. Lemuel Stoughton, East Windsor.
His Hon. O. F. Winchester, New Haven. Hon. H. Lynde Harrison, Branford.
Hon. Jasper H. Bolton, Stafford. Rev. Birdsey G. Northrop, New Haven.

1867–8.

His Exc. James E. English, New Haven. Hon. Miles T. Granger, North Canaan.
His Hon. Ephraim H. Hyde, Stafford. Hon. Amos J. Gallup, Sterling.
Hon. George Beach, Hartford. Rev. Birdsey G. Northrop, New Haven.

1868–9.

His Exc. James E. English, New Haven. Hon. Isaac T. Rogers, Milford.
His Hon. Ephraim H. Hyde, Stafford. Hon. Albert Austin, Suffield.
Hon. Edwin H. Bugbee, Dayville. Rev. Birdsey G. Northrop, New Haven.

1869–70.

His Exc. Marshall Jewell, Hartford. Hon. Erasmus D. Avery, Groton.
His Hon. Francis Wayland, New Haven. Hon. James S. Taylor, Danbury.
Hon. George M. Landers, New Britain. Rev. Birdsey G. Northrop, New Haven.

III. INSTRUCTORS,

Arranged alphabetically, with their chief departments of instruction and the dates when their services in the Scientific School began. These dates in some instances do not coincide with the dates of the professorships in Yale College held by the persons named. The latter may be learned from the "Triennial Catalogue."

PROFESSORS.

1864	William Henry Brewer,	Agriculture.
1855	George Jarvis Brush,	Mineralogy and Metallurgy.
1856	James Dwight Dana,	Geology and Mineralogy.
1864	Daniel Cady Eaton,	Botany.
1860	Daniel Coit Gilman,	Physical Geography and History.
1855	Samuel William Johnson,	Agricultural and Analytical Chemistry.
1859	Chester Smith Lyman,	Industrial Mechanics and Physics.
1866	Othniel Charles Marsh,	Palæontology.
1846–52	*John Pitkin Norton,	Agricultural Chemistry.
1852	William Augustus Norton,	Civil Engineering and Mathematics.
1853–64	*John Addison Porter,	Agricultural Chemistry.
1868	Benjamin S. Roberts,	Military Science.
1865–68	Alfred Perkins Rockwell,	Mining.
1846	Benjamin Silliman,	General Chemistry.
1864	Addison Emory Verrill,	Zoology.
1860	William Dwight Whitney,	Modern Languages and Linguistics.

ASSOCIATE INSTRUCTORS AND ASSISTANTS.

1860	Oscar D. Allen,	Chemistry.
1868	Wilbur O. Atwater,	Chemistry.
1865	John Avery,	Physics, etc.

* Deceased.

1856	William A. Anthony,	Eng
1856	Louis Bail,	
1860	Mark Bailey,	E
1859	John M. Blake,	C
1867	Volney G. Barbour,	Eng
1865	Frank H. Bradley,	
1864	Fisk P. Brewer,	His
1868	Eugene S. Bristol,	C
1851	William J. Craw,	C
1863	Peter Collier,	Eng
1863	Franklin B. Dexter,	His
1849	Henry Erni,	Chemistry an
1861	D. Grenville French,	C
1862	Watson A. Goodyear,	Eng
1863	William L Kingsley,	English L
1859	Charles S. Kittredge,	Eng
1865	John J. Matthias,	Cl
1861	William C. Minor,	
1867	William G. Mixter,	Cl
1854	Alonzo T. Mosman,	Eng
1867	Edward T. Nelson,	Mi
1860	George G. Percival,	Cl
1855	Charles H. Porter,	Cl
1853	Albert B. Rogers,	Eng
1864	Joseph A. Rogers,	Eng
1856	Henry M. Seeley,	Cl
1866	Charles J. Sheffield,	Cl
1867	Sidney I. Smith,	
1865	Adolph von Steinwehr,	Military
1865	James B. Stone,	Eng
1865	Frederick F. Thomas,	Cl
1857	Edward H. Twining,	Cl
1849	Mason C. Weld,	Cl
1867	Daniel H. Wells,	Mat
1863	Moses C. White,	
1868	Henry Shaler Williams,	Palæo
1850	Henry Wurtz,	Ch

In addition to the instructors above named, President Woolsey, and P
B. Silliman, Sen., Jonathan Knight, Denison Olmsted, Henry Dutto
Loomis, Noah Porter, Leonard J. Sanford, (and probably other professo
freely admitted the members of this department, to their lectures be
Academical students.

IV. GRADUATES.

*A Catalogue of those students in the Scientific School who have been admitt
President and Fellows of Yale College to the degree of Doctor of Ph
(Ph.D.), Bachelor of Philosophy, (Ph.B.), or Civil Engineer, (C.E. or S.*

Doctors of Philosophy.

1861.

Eugene Schuyler, B.A., 1859, LL.B., Co-*lumb. 1863.*
U. S. Consul in Moscow.

Arthur W. Wright, B.A., 1859.
Instructor in Physics in the Sheffield School; Professor of Physics in College, Williamstown, Mass.

1863.

Josiah W. Gibbs, B.A., 1858, M.A., 1861.
Tutor in Yale College.

1866.

Francis E. Loomis, B.A., 1864, M.A., 1867.
Charles F. McLean, B.A., 1864.
Chas. G. Rockwood, B.A., 1864, M.A., 1867.
Professor of Physics in Bowdoin College, Brunswick, Me.

1866.

Peter Collier, B.A., 1861; M.A., 1864.
Professor of Chem., Mineral. and Metall. in the University of Vermont, Burlington.

1867.

William North Rice, A.B., Wesl., 1865.
Professor of Geol. and Nat. Hist., in Wesleyan Univ., Middletown.

Total 8.

Civil Engineers.

1860.

Charles Stewart Kittredge, Ph.B., 1858.
Assistant in Engineering.

1861.

Joseph Addison Rogers, Ph.B., 1860.
Assistant in Engineering; Observer in the National Observatory, Washington, D. C.; Assistant in the Hydrographic Office U. S. Navy Dept., Washington.

1866.

Theron Skeel, Ph.B., 1865.
Assist. Engineer U. S. Navy.

James Bennett Stone, Ph.B., 1865.
Assistant in Engineering.

1868.

Daniel Halsey Wells, Ph.B., 1867.
Assistant in Engineering.

Total 5.

Bachelors of Philosophy.

1852. (8)

William Phipps Blake, A.M., Dart., 1863.
Professor of Geology and Mineralogy in the College of California; Geologist to the U. S. Pacific R. R. Ex. under
William Henry Brewer, A.M., 1859.
Professor of Chemistry in Washington College, Penn.; Botanist to the Geological Survey of California; Professor of Natural Science in the College of California; Norton Professor of Agriculture, Yale College.
George Jarvis Brush, A.M., 1857.
Professor of Mineralogy and Metallurgy, Yale College.
William Jarvis Craw.
Assistant in Chemistry.
William Arthur Shepard, M. A., *al.*
Professor in Randolph Macon College, Va.
Mason Cogswell Weld, (Honorary, 1858).
Ludwig Stadtmüller, (Honorary, 1858).
*George Washington Weyman, Ph.D., Göttingen, 1855. *1864

1853. (7)

Charles Francis Chessman.
William Batcheler Cochran.
Daniel Farrand Henry.
Benjamin Cutler Jillson, M.D., *al.*
Assistant Professor of Chemistry, Mineralogy and Geology in Cumberland University, Tenn.; Professor of Natural Science in the Western University of Pennsylvania.
*William Henry McRuer. *1858
Gilbert Ezekiel Palen.
Albert Bowman Rogers.
Assistant in Engineering.

1854. (7)

Stephen Lyford Crosby.
*John Antoine Duvillard. *1865
Rafael Espinosa.
Alonzo Tyler Mosman.
Assistant in Engineering.
David Ball Parsons.
George Bowen Pierson.
Adrian Terry, A.B., 1852.

1855. (7)

Frederick Hoyt Allen.
James Clarence McGregor.
Ira Moore.
Howell W. St. John.
Onofre Vengohechea.
George D. Walcott.
Thomas A. Wilcox.

1856. (12)

Armand Boisblanc.
Joseph Hill Brinton.
Nathan Smith Bronson.
Gideon Horace Candee.
Erastus Lyman DeForest, A.B., 1854, A.M., 1867.
George Franklin Fuller.
George W. Lyle.
Louis Peck Morehouse.
Isadore Plata.
Henry Martyn Seely, M.D., Berkshire Medical School, A.M., 1860.
Professor of Chemistry and Toxicology in University of Vermont and in Berkshire Medical School; Professor of Chemistry and Natural Science in Middlebury College.
Matthew Watson.
Lewis Williams.

1857. (9)

Edward Curtis.
John King Gilbert.
Charles Harger.
Edmund Perlee Herrick.
Alexander Hamilton Kent.
David Bigum Martin.
G. Harrison Meade.
William Henry Pike.
Selden Silliman Richards.

1858. (12)

Demetrius Thomas Arosmena.
George Frederick Barker, M.D., Medical College, Albany, 1863.
Professor of Natural Science in Western University of Pennsylvania; and of Physiological Chemistry and Toxicology, Yale College.
John Marcus Blake, Assistant in Chemistry.
Julius Gay, A.B., 1856.
Henry Kelly Hodges.
Horatio Kendall King.
Charles Stewart Kittredge, C.E., 186
Fidel Pombo.
Alfred Perkins Rockwell, A.B., A.M., 1858.
Prof. of Mining, in Yale College; and Mass. Inst. of Technology, Boston.
*Edward Sackett. * 1861–2.
Orson Cowles Sparrow, A.B., 1854, Long Isl. Hosp. Med. Coll. 1864.
John Davenport Wheeler.

1859. (7)

Franklin Booth.
Henry Augustus DuBois, M.D., 1861.
William Buck Dwight, A.B., 1854.
Alexis Wynns Harriott, A.B., 1856; A.M., 1859.
George Dallas Seeley.
George Hazard Smith.
Sutherland Douglas Twining, M.D.,

1860. (6)

Clifford Coddington.
Alfred William Hearn.
Edwin Hutchinson, M.D., New York College of Physicians and Surgeons, 1866.
Edward Augustus Manice, A.B., A.M., 1861.
Joseph Addison Rogers, C.E., 1866.
Assistant in Engineering.
Walter Scott Sheafer.

1861. (7)

Oscar Dana Allen.
Assistant in Chemistry.
Charles W. Burrage.
José Filomeno Cifuentes.
Salomé Martinez.
Gideon Emmett Moore.
Carrington Howard Raymond.
Joshua Sands.

1862. (6)

Charles Henry Bunce.
John Grifian.
Clarence King.
Chief of the U. S. Geol. Survey of the 40th Parallel.
Daniel Smith Mead.
Samuel Parsons.
Hubert Cowles Ward.

1863. (3)

Watson Andrews Goodyear.
Arnold Hague.

Landon Ketchum, (Honorary, 1865).
* Ignatio M. Megia. * 1865.

1864. (9)

Charles Bill.
Robert Long Brownfield.
Beverly Scott Burton.
Assistant in Chemistry.
Edwin Wallace Carpenter.
Ellsworth Daggett.

Frederick Farnsworth, M. D., New York, 1867.
Albert Hiller Roffe.
Henry Dyer Tiffany.
Arthur Van Harlingen, M.D., Univ. Pa., 1867.

1865. (12)

William Henry Glenny.
Charles Holt.
Francis J. Leavens.
Albert Parsons Massey.
Alexander Smith Palmer.
Sanford Robinson.
Henry Rogers.
Theron Skeel, C.E., 1866.
Engineer, U. S. Navy.

James Bennett Stone, C.E., 1866.
Assistant in Engineering.
Frederick Folger Thomas, A.B., 1863, A.M., 1866.
Samuel Reading Throckmorton, A.B., 1863, A.M., 1866.
Martin Van Harlingen.

1866. (5)

George Douglass Colt.
Adrian John Ebell.
Charles Henry Gauss.
Alexander Ufford McAllister.

John Jacob Matthias, A.B. Univ. of New York, 1862, A.M., *ibid.*, 1865.
Assistant in Chemistry.

1867. (12)

Volney Giles Barbour.
Assistant in Engineering, Professor of Civil Engineering in the University of Vermont.
John Kennedy Beeson.
Alfred Caldwell.
Samuel Hosmer Chittenden.
Lyman Stewart Ferry.
Peter Houtz Grove.
Robert Michael Grove.
Charles Henry Hubbard.

William Gilbert Mixter.
Assistant in Chemistry.
William Harmon Niles.
Sidney Irving Smith.
Assistant in Zoology.
Daniel Halsey Wells, C.E., 1868.
Assistant in Engineering.
Joseph Thompson Whittelsey.
Luther Hodges Wood, M.D., 1869.

1868. (26)

Wellington Miles Andrew.
Leonard Strong Austin.
George Franklin Bailey.
Samuel Atkins Barbour.
Frederick Converse Beach.
James deTrafford Blackstone.
Eugene Stuart Bristol.
Albert Gardiner Clark.
Henry Marchant Dudley.
Henry Turner Eddy, B.A., 1867.
Barton Darlington Evans.
Edward Forsyth Finney.
James Fowler.

Frank Morton Guthrie.
John Corey Hersey.
George Anson Jackson.
Joseph Scott McKell.
Charles Kinney Needham.
Frederick George Noonan.
Lyman Bradley Parshall.
William Wallace Redfield.
Alexander Renick.
Joseph Perkins Rockwell.
Lewis Bridge Stone.
Samuel Swift.
Henry Shaler Williams.

Total, 155

V. STUDENTS.

The following catalogue is intended to include the names o
who have been members of the Scientific School of Yale Col
since its beginning in 1846. Possibly a very few names
inserted of those who were students of the Philosophical De
ment, without having any connection with the Scientific Sch
and so also two or three names may be omitted which sh
have been included. Such errors if pointed out will be corre
in future impressions of the catalogue. Where the present
dences are known they are given; otherwise the paternal hon
the college residence is mentioned. No efforts have been mad
ascertain the professions or employments of the persons nam
and consequently only a few are specified. The star prefixed
name indicates death. The academic degrees were conferre
Yale College, unless otherwise stated. Every person who can
nish the information which this catalogue should include is earne
invited to write at once to the "Secretary of the Sheffield S
tific School, New Haven."

NAMES.

1866–9	Abbot, William Greene,	Norwich,
1868–9	Abbott, James Whitin, A.B.	New Haven,
1855–8	Abernethy, William,	Oregon City, Or
1862	Abrahams, Woodward,	Baltimore
1867–9	Adam, Joseph Sampson,	Canaa
1851–2	Alexander, William Felix, A.B.	Washington
1853–5	Allen, Frederick Hoyt, PH.B.	New Haven,
1861–4	Allen, Oscar Dana, PH.B.	Lewistown,
	Chemist in the Freedom Iron and Steel Works.	
1858–9	Alsop, Joseph W. Jr. (Agric.)	New York
1852–3	*Alter, Joseph Henry, A.M. (Merc.) (* 1854.)	Philadelphi
1860–1	Ambler, Daniel Griffith,	Jacksonville
1855–7	Anderson, John,	Bedford Spring
1865–8	Andrew, Wellington Miles, PH.B. (Eng.)	Orange,
1851–2	Andrews, E. B.	Mariet
	Professor of Chem. & Geol. in Marietta College.	
1868–9	Andrews, Horace,	New York
1855–6	Andrews, Mark,	Rochester,
1857–60	Andrus, E. Van Arsdale, (Eng.)	Newark,

1855–6	Anthony, William A. PH.B. Professor of Chem. & Mineral. in Antioch Coll., Ohio.	Antioch, O.
1856–8	Arosmena, Demetrio Thomas, PH.B. (Merc.)	New York City.
1854–5	Atwater, Montgomery,	New Haven, Conn.
1867–9	Atwater, Wilbur Olin, M.A. Wesl.	Brandon, Vt.
	Atwood, Thomas Ira.	Greenport, N. Y.
1865–9	Austin, Leonard Strong, PH.B. (Mech. Eng.)	Stratford, Conn.
1868–9	Ayres, Henry Wilcox,	Hartford, Conn.
1868–9	Bacon, Edwin Faxon,	Norwalk, Conn.
1865–8	Bailey, George Franklin, PH.B. (Eng.)	Rutland Centre, Vt.
1867–9	Bailey, Henry Moore,	Rutland, Vt.
1865–6	Baird, George William, A.B. Lieut. U. S. Army.	Milford, Conn.
1865–7	Baker, Henry Norris. (Merc.)	Brooklyn, N, Y.
1857–9	Baker, William Martin. (Teacher.)	New York City.
1866–7	Baldwin, John Thornton,	St. Louis, Mo.
1867–9	Ballard, Charles Thruston,	Louisville, Ky.
1865–8	Barbour, Samuel Atkins, PH.B. (Eng.)	Bristol, Conn.
1864–8	Barbour, Volney Giles, PH.B., C.E. Prof. of Civil Eng. in Univ. of Vermont.	Burlington, Vt.
1856–8	Barker, George Frederick, PH.B., M.D. Alb. Prof. of Chem. and Geol. in Wheaton Coll., Ill.; Prof. of Nat. Sci. in West. Univ., Penn.; Prof. of Physiol., Chem. and Toxicology, Yale Coll.	New Haven, Conn.
1847–8 '51–2	*Barnard, John Bacon, * 1852.	New Haven, Conn.
1850–1	Barnes, Lorin, B.A. (Agric.)	Bloomingdale, Ill.
1854–5	Barrows, Elijah P. (Teacher.)	Andover, Mass.
1852–3	Bastida, Julio,	Trinidad, Cuba.
1851–2	Battle, John J.	Edgecombe Co. N. C.
1864–6	Beach, Charles Yale. (Merc.)	Brooklyn, N. Y.
1865–8	Beach, Frederick Converse, PH.B.	Stratford, Conn.
1867–8	Beers, Herbert Booth,	Brookfield, Conn.
1864–7	Beeson, John Kennedy, PH.B.	Uniontown, Pa.
1863–4	Belden, Herbert C., M.D. *al.*	West Springfield, Mass.
1866–9	Belknap, William Richardson,	Louisville, Ky.
1866–8	Bennett, Thomas Gray. (Eng.)	New Haven, Conn.
1858–60	*Bergen, William H.	Brooklyn, N. Y.
1851–2	Bigelow, Artemas, B.A. Wesl. Univ.	Penn Yan, N. Y.
1861–4	Bill, Charles, PH.B. (Publisher.)	Norwich, Conn.
1855–6	Billings, Arthur W.	Hatfield, Mass.
1854–7	Bissell, Evelyn Lyman, M.D. (Physician.)	New Haven, Conn.
1859–61	Bissell, Hezekiah,	East Windsor, Conn.
1866–9	Bissell, Roman Augustus,	Detroit, Mich.
1865–8	Blackstone, James De Trafford,	Norwich, Conn.
1855–6	Blackwood, Joseph,	Philadelphia, Pa.
1858–60	Blake, Eli Whitney, M.A. Professor of Industr. Mechanics and Physics in Cornell University.	Ithaca, N. Y.
1853–5	Blake, George A.	New Haven, Conn.
1856–9	Blake, John Marcus, PH.B.	New Haven, Conn.
1862–3	Blake, Theodore A. B.A. N. Y. Free Acad. (Civil and Min. Eng.)	San Francisco, Cal.

1849–52	Blake, William Phipps, PH.B. (Geologist.) Professor in the College of California; Geologist to the U. S. Pacific R. R.—Ex. under Lieut. R. S. Williamson.	Washington, D. C.
1849–50	Blake, William S. (Manufacturer.)	Boston, Mass.
1859–60	Blinn, William H. (Agric.)	Whallonsburgh, N. Y.
1849–50	Bliss, Sylvester S.	Springfield, Mass.
1853–4	Boies, Edward F.	Keene, N. H.
1854–6	Boisblanc, Armand, PH.B. (Eng.)	New Orleans, La.
1857–9	Booth, Franklin, PH.B.	E. Windsor, Conn.
1854–5	Bosworth, Samuel C.	Berlin, Conn.
1852–4	Bowers, Charles. (Eng.)	Lowell, Mass.
1853–4	Bowmann, James Pierre, B.A. Trin.	W. Feliciana, La.
1863–7	Bradley, Frank Howe, B.A. (Geologist.) Professor of Nat. Sci. in Hanover College, Indiana.	Hanover, Ind.
1867–9	Brandegee, Townshend Stith,	Berlin, Conn.
1856–7	Brandon, Robert Lindsley, B.A.	Fort Adams, Wilkinson Co., Miss.
1849–50	Brewer, Francis A.	Springfield, Mass.
1848–50	Brewer, William Henry, PH.B., M.A. Botanist to Geological Survey of California; Norton Prof. of Agriculture in Yale Coll.	New Haven, Conn.
1852–3	Brinkerhoff, William, B.A. *al.* Professor in Franklin Coll., Ind.	Franklin, Ind.
1854–5	Brinley, Benjamin F	Paris, Ky.
1866–9	Brinley, Charles Augustus,	Hartford, Conn.
1867–9	Brinsmade, Daniel Seymour,	Trumbull, Conn.
1852–3	Brinton, Caleb,	Westchester, Pa.
1852–6	Brinton, Joseph Hill, PH.B.	Thornbury, Pa.
1863–9	Bristol, Eugene Stuart, PH.B. (Chem.) Assistant in Metallurgy.	New Haven, Conn.
1854–6	Bronson, Nathan Smith, PH.B.	New Haven, Conn.
1867–8	Bronson, Stephen Henry, M.D.	New Haven, Conn.
1867–9	Brooks, Charles Peter,	Blooming Grove, N. Y.
1860–61	* Brown, Nathan L. Church. * 1863.	Boston, Mass.
1847–8	Brown, Percival,	Jamaica, W. I.
1862–4	Brownfield, Robert Long, PH.B. (Eng.)	Uniontown, Pa.
1861–3	Browning, Abraham M.	Camden, N. J.
1847–8	Brownson, John O.	Norwich, Conn.
1848–50 1852–3	Brush, George Jarvis, PH.B. M.A. Professor of Metallurgy and Mineralogy in Yale Coll.	New Haven, Conn.
1866–9	Buck, Francis Dudley,	New York City.
1868–9	Buckingham, Henry Gaylord. (Teacher.)	Stamford, Conn.
1860–1	Buckley, Joseph Hall,	Cornwallis, N. S.
1856–7	Bulkley, George, M.A.	Southport, Conn.
1862–3	Bull, Edward S. (Merc.)	New York City.
1854–5	Bullard, Richard P.	Perry, N. Y.
1860–2	Bunce, Charles Henry, PH.B. (Eng.)	Hartford, Conn.
1849–51	Bunce, Jonathan B. (Merc.)	Hartford, Conn.
1867–9	Burkett, Ralph Howard,	Hartford, Conn.
1852–3 1859–61	Burrage, Charles W. PH.B. (Civil Engineer.)	Leominster, Mass.

1868–9	Burt, Luther White,	Hartford, Conn.
1862–8	Burton, Beverly Scott, PH.B. Chemist to Butchers' Steel Works.	Philadelphia, Pa.
1866–7	Burwash, Nathaniel, M.A. Prof. of Natural Science, Victoria Coll., C. W.	
1868–9	Bush, James Clark,	New Haven, Conn.
1868–9	Bussing, Cornelius Wallis. (Merc.)	Brooklyn, N. Y.
1865–6	Butler, Henry V. (Paper Manufacturer.)	Paterson, N. J.
1865–7	Caldwell, Alfred, PH.B. (Lawyer.)	Wheeling, W. Va.
1867–8	Caldwell, Harry,	Wheeling W. Va.
1867–9	Calvert, Thomas Elwood,	Newtown, Pa.
1853–4	Calvo, Dario,	Bogota, N. Granada.
1867–8	Cameron, Angus, LL.B.	LeRoy, N. Y.
1866–7	Campbell, Charles,	Milburn, N. J.
1865–6	Candee, Benjamin Dutton,	Branford, Conn.
1854–6	Candee, Gideon Horatio, PH.B. (Eng.)	Oxford, Conn.
1868–9	Carleton, Horace Morrisson,	New York City.
1855–6	Carmalt, William H.	Friendsville, Pa.
1861–4	Carpenter, Edwin Wallace, PH.B. (Editor.)	Helena, Montana.
1852–3	Carpenter, Thornton, M.A. So. Carol.	Camden, S. C.
1856–7	Cassatt, Alexander J.	Westchester, Pa.
1864–6	Chapman, Curtis,	Peekskill, N. Y.
1865–7	Chapman James W.	Warsaw, N. Y.
1868–9	Chapman, Sherman Hartwell, A.B., M.D.	Bridgeport, Conn.
1854–5	Cheseboro, Joseph,	Stonington, Conn.
1852–3	Chessman, Charles Francis, PH.B. (Eng.)	Milford, Mass.
1866–9	Chidsey, Andrew Dwight,	New Haven, Conn.
1868–9	Chittenden, George Benjamin,	East River, Conn.
1864–7	Chittenden, Samuel Hosmer, PH.B. (Eng.) Assist. Engineer engaged on Union Pacific R. R.	Madison, Conn.
1852–3	Chotard, J. Charles,	Natchez, Miss.
1850–1	Chubb, A. La Mont. (Manuf. of Agric. Impl.)	Grand Rapids, Mich.
1867	Churchill, Frederic Hosea,	New Britain, Conn.
1858–60	Cifuentes, José Filomeno, PH.B.	Copiapo, Chili.
1865–8	Clark, Albert Gardiner, PH.B.	Cincinnati, O.
1866–9	Clark, Clarence Marcellus,	New Haven, Conn.
1849–50	Clarke, Charles G.	Albany, N, Y.
1867	Clarke, Dorr,	Batavia, N. Y.
1864–6	Clarke, Frederic William,	San Francisco, Cal.
1848–9	*Clark, Lucius. (Manufacturer of Paper.)	Northampton, Mass.
1852–3 1855–6	Cochran, William Batcheler, PH.B. (Eng.)	Methuen, Mass.
1858–60	Coddington, Clifford, PH.B. (Eng.)	New York City.
1863–6	Coit, George Douglass, PH.B.	Norwich, Conn.
1861–7	Collier, Peter, M.A. PH.D. Professor of Chemistry, etc. in the University of Vermont.	Burlington, Vt.
1866–8	*Collier, Thomas Fassitt, B.A. W. U., St. Louis. (*1868.)	St. Louis, Mo.
1854–5	Colton, John W.	Springfield, Mass.
1866–9	Conkling, Alfred Ronald,	New York City

1852–3	Conner, Farar B.	Natcl
1850–1	Conner, Sydney S.	Day
1862–3	Conwell, Charles H.	Worthingt
1861–3	Cook, William, B.A. (Chem.)	New Y
1868–9	Cook, William Burt,	Huntingt
1855–6	Cooley, Edwin A.	Amhe
1849–50	Covington, Turpin, M.D., *al.*	Vicksbu
1867–8	Cragin, John Holton,	New Hav
1865–6	Craig, Willie Lawrence,	Peeksk
1848–53	Craw, William Jarvis, PH.B.	Norwa
1849–50	Crooke, John J. (Metallurgist.)	New Y
1862–6	Crooke, Robert L. (Manufacturer.)	Flatbu
1852–4	Crosby, Stephen Lyford, PH.B. (Civ. Eng.)	Manches
1855–7	Curtis, Edward, PH.B. (Eng.)	New Y
1866–9	Curtis, Frederick Smillie,	Stratfo
1851–2	Curtis, James M.	Covent
1848–9	Curtiss, Frederick B.	Buffa
1867–9	Cutter, William Richard,	Wobu
1863–4	Daggett, Alfred. (Druggist.)	New Hav
1862–5	Daggett, Ellsworth, PH.B. (Mining Engineer.)	New Hav
1851–2	Dakin, Francis E., M.A. Ham.	New Y
1868–9	Dart, Joseph,	Buffa
1868–9	Dart, Justus Vinton,	New Lond
1861–2	Davenport, James Boorman. (Merc.)	New Y
1868–9	Davenport, Russel Wheeler,	New Y
1868–9	Davis, Benjamin Franklin,	Roc
1864–5	Davis, Charles Martel,	Lafay
1865–7	Davis, John Morrison,	Allegheny
1852–3	Day, Austin G. (Manufacturer.)	Naugatu
1851–2	Day, Edmund,	W. Springfie
1853–4	Dayton, Lewis M. (Eng.) Bvt. Lt. Col. U. S. A.	Mad
1864–5	Dean, Gilbert Smith,	Poughkeep
1854–6	DeForest, Erastus Lyman, A.M., PH.B.	Watertow
1852–3	Deming, Frederick,	Farmingt
1857–9	Dering, Sylvester,	Uti
1856–7	Dexter, Benjamin Franklin,	Rochest
1849–50	Dickerman, Charles. (Manufact.)	New Hav
1868–9	Dickerson, Frank,	New Y
1867–9	Dickinson, Rev. John. (Clergyman.)	Westvi
1868–9	Dickson, Frederick Stoever,	West Ch
1854–5	Divine, Robert L.	Sheldra
1865–7	Dodge, Charles Richards, Assist. in Entom. U. S. Agr. Dept.	Washing
1866–7	Doten, Charles Arthur,	Bridgep
1849–50	*Douglass, William,	Louis
1866–7	Dow, William Franklin. (Civil Eng.) Assist. Eng. on the Brunswick and Macon R. R., Georgia.	Detr
1865–6	Dow, Virgil Maro, M.A., M.D. (Druggist.)	New Hav
1848–9	*Drake, H. F.*	Natc

1863-4	Drown, Thomas M., M.D., Univ. of Penn. (Chem.)	Philadelphia, Penn.
1866-9	DuBois, Augustus Jay,	New Haven, Conn.
1857-9	DuBois, Henry Augustus, PH.B., M.D. Surgeon U. S. Army.	New Haven, Conn.
1865-8	Dudley, Henry Marchant, PH.B.	Whitinsville, Mass.
1854-5	Duer, Edward Louis, M.A., M.D. Univ. Pa.,	Crosswicks, N. J.
1865-6	DuPre, Warren,	Spartenburg, S. C.
1848-9	Durand, Levi. (Agric.)	Derby, Conn.
1868-9	Durand, William Cecil,	Milford, Conn.
1867-8	Durand, Jesse,	Warwick, M. J.
1865-6	Durant, Warren A.	Boston, Mass.
1855-7	*Dutton, Arthur H. (West Point, 1861,) *1864. Capt. Engineers, U. S. A., Col. 21st Conn. Vol.	Wallingford, Conn.
1852-4	*Duvillard, John Antoine, PH.B. (*1865.) Lieut. 12th U. S. Inf.	Cape Vincent, N. Y.
1858-9	Dwight, William Buck, M.A. PH.B. (Teacher.)	West Point, N. Y.
1868-9	Dwinelle, Charles Hascall,	Oakland, Cal.
1851-2	Dyer, Henry A. (Merc.) Secretary Conn. State Agricultural Society.	Hartford, Conn.
1851-2	Easter, Rev. John D., M.A. PH.D. Heidelberg, Prof. of Nat. Philos. and Chem. in Univ. of Georgia.	St. Louis, Mo.
1857-8	Eaton, Daniel Cady, M.A. B. S., Harvard, Prof. of Botany, Yale Coll.	New Haven, Conn.
1863-6	Ebell, Adrian John, PH.B. (Lecturer.)	Purgittsville P. O., W. Va.
1867-8	Eddy, Henry Turner, B.A. PH.B.	North Bridgewater, Mass.
1852-3	Edes, Henry W. (Eng.)	Boston, Mass.
1854-5	Egleston, Thomas, M.A. (Mining Eng.) Professor of Metall. and Mineral. in the School of Mines, Columbia College, N. Y.	New York City.
1861-3	Engell, George Phillip,	Cherry Valley, N. Y.
1852-4	Espinosa, Rafael, PH.B. (Eng.)	Bogota, N. Granada
1856-8	Evans, Barton Darlington, PH.B. (Editor.)	West Chester, Pa.
1847-8	Evans, Gurdon, M. A. (Teacher.)	Deruyter, N. Y.
1861-4	Farnsworth, Frederick, PH.B., M.D. New York.	Norwich Conn.
1861-4	Fenner, Arnold Borden. (Manufacturer.)	Plainfield, Conn.
1853-4	Ferguson, John C., B.A. Union Coll.	Charlotteville, N. Y.
1868-9	Ferry, Charles Addison,	New Haven, Conn.
1864-7	Ferry, Lyman Stewart, PH.B. (Eng.) Assist. Eng. on the Air Line R. R., Conn.	New Haven, Ct.
1865-8	Finney, Edward Forsyth, PH.B. (Eng.)	St. Louis, Mo.
1857	Fisher, Robert A., M.D., *al.* Prof. of Chem., Mining and Metall. in the Univ. of California.	San Francisco, Cal.
1868-9	Flagg, Wilbur Wells,	Yonkers, N. Y.
1866-9	Folsom, Joseph Robinson,	New Haven, Conn.
1866-8	Foote, Arthur DeWint,	Guilford, Conn.
1864-5	Ford, James B.	New York City.
1857-8	Foster, William R., Jr.	New York City.
1847-8	Fowler, Henry D.	Newburgh, N. Y.
1865-8	Fowler, James, PH.B.	Westfield, Mass.
1865-6	Fowler, John Henry,	East Haven Conn.
1859-62	*French, D. Grenville,	Turner, Me.

1854–6	Fuller, George Franklin, PH.B.	Brighton, Mass.
1864–6	Gardiner, Charles Starr,	Milwaukee, Wis.
1867–8	Gardner, James Terry, PH.B. (Hon.) Topographer to the U. S. Surv. of 40th Parallel.	Troy, N. Y.
1864–6	Gauss, Charles Henry PH.B. (Eng.)	St. Charles, Mo.
1856–8	Gay, Julius, M.A. PH.B. (Eng.)	Farmington, Conn.
1864–6	Geist, Alfred William. (Assayer.)	Boston, Mass.
1858–63	Gibbs, Josiah Willard, M.A., PH.D.	New Haven, Conn.
1848–9	Giddings, Frederick Salmon, B.A. Illin. LL.B. Yale,	Collinsville, Ill.
1855–7	Gilbert, John King, PH.B.	Concordia, La.
1852–3	Gillespie, William C.	Natchez, Miss.
1853–5	Gilman, William Charles. (Merc.)	New York City.
1862–5	Glenny, William Henry, PH.B. (Merc.)	Buffalo, N. Y.
1867–8	Glenny, Bryant Burwell,	Buffalo, N. Y.
1861–4	Goodyear, Watson Andrews, PH.B. (Civ. & Min. Eng.)	S. Francisco, Cal.
1868–9	Gorham, Charles Elisha,	New Haven Conn.
1850–1	Gould, Thomas. (Agric.)	Aurora, N. Y.
1867–9	Grant, Justus Herbert,	Auburn, N. Y.
1867–8	Gray, George Harrison,	Springfield, Mass.
1868–6	Green, Charles Henry,	Cincinnati, O.
1868–9	Greene, William Parkinson,	Norwich, Conn.
1866–8	Griggs, Julian,	Chaplin, Conn.
1860–2	Griñan, John, PH.B. (Eng.)	Santiago, Cuba.
1868–9	Griswold, Charles Woodford,	New Britain, Conn.
1868–9	Griswold, John Wool,	Troy, N. Y.
1864–8	Grove, John H. (Iron Master.)	Danville, Pa.
1864–7	Grove, Joshua Comly. (Iron Master.)	Danville, Pa.
1864–8	Grove, Peter Houtz. (Iron Master.)	Danville, Pa.
1864–7	Grove, Robert Michael, PH.B. (Iron Master.)	Danville, Pa.
1864–8	Guthrie, Frank Morton, PH.B.	Orange, N. J.
1868–9	Günster, Peter Francis,	Scranton, Pa.
1861–3	Hague, Arnold, PH.B. (Chem. and Metal.)	Boston, Mass.
1868–9	Hall, Alvah William,	Stamford, Conn.
1866–8	Hanford, David,	Middletown, N. Y.
1852–3	Harding, W.	Watertown, Mass.
1856–7	Harger, Charles, PH.B. (Eng.)	Oxford, Conn.
1856–9	Harriott, Alexis Wynne, M.A., PH.B. (Eng.)	Turks Island, W. I.
1867–9	Harris, William Sturges,	Binghampton, N. Y.
1866–7	Hartt, Charles Frederick, B.A. Acadia Coll.	Poughkeepsie, N. Y.
1863–4	Hartley, Edward, Assist. on the Geol. Surv. of Canada.	Montreal, C. E.
1863–4	Harvey, Robert H.	Somerset, Bermuda.
1864–6	Haskell, Dudley Chase,	Lawrence, Kansas.
1867–9	Hastings, Charles Sheldon,	Hartford, Conn.
1865–7	Hawes, George Wesson,	Worcester, Mass.
1853–4	Hawkins, Charles A.	Birmingham, Conn.
1868–9	Hawkins, Philip Owen,	Wakefield, R. I.
1848–9 1864–5	Hayden, William Hallock, B.A. (Metallurgist.)	Columbus, O.

Hazard, Robert G. — New Haven, Conn.
Head, John Quincy. — Utica, N. Y.
Hearn, Alfred Williams, PH.B. (Merc) — N. Y. City.
Henry, Daniel Farrand, PH.B. (Assist. U. S. Coast Surv.) — Detroit, Mich.
Hepburn, William Irvine, — Williamsport, Pa.
Herrick, Edmund Perlee, PH.B. — Athens, Pa.
Hersey, John Corey, PH.B. — Bridgeport, Conn.
Higgins, Alfred W. — Buffalo, N. Y.
Hill, Alfred Banks, — Redding, Conn.
Hillyer, William Silliman, B.A., And. Coll. Inst. — New York City.
Hinds, Franklin Allen, — Watertown, N. Y.
Hinds, William Alfred, — Wallingford, Conn.
Hodges, Henry Kelly, PH.B. — New Orleans, La.
Hoes, Edward Van Buren, — Ottawa, Ill.
Hollick, George Frederick, M.D., New York, — Staten Island, N. Y.
Holly, Edward M. K. — New Haven, Conn.
Holmes, Samuel Nelson. (Cadet, U. S. Mil. Ac.) — Boonton, N. J.
Holt, Charles, PH.B. (Manufacturer.) — New Haven, Conn.
Hopson, John M. — Farrardsville, Pa.
Hopson, William Rufus, — Bridgeport, Conn.
Horan, Rev. E. J. — Quebec, Canada.
Hornblower, Joseph Courten, — Paterson, N. J.
Hoyt, Edwin. (Agric.) — New Canaan, Conn.
Hubbard, Charles Henry, PH.B. — Sandusky, O.
Hubbard, David L. (Tanner.) — Glastenbury, Conn.
Hubbell, Rev. William Stone, B.A. — No. Stonington, Conn.
Hulst, Nelson Powell, B.A. — Washington, D. C.
Humphrey, Henry Correll, — Stamford, Conn.
Humphreys, Henry H. — Washington, D. C.
Hungerford, Edward, M.A. — Burlington, Vt.
Prof. of Chem. and Geol. in the Univ. of Vermont.
Hunt, Henry O. (Assayer.) — San Francisco, Cal.
Hurlbut, George, — Brooklyn, L. I.
Hutchinson, Edwin, PH.B., M.D., New York, — Utica, N. Y.
Ives, Charles Linnaeus, M.A., M.D. Jeff. Med. Coll., — New Haven, Conn.
Professor in the Medical Department, Yale College.
Jackson, C. Wolcott, — Newark, N. J.
Jackson, George Anson, PH.B. — North Adams, Mass.
Jenks, Stephen A. (Manufacturer) — Central Falls, R. I.
Jennings, Leverett A. — Wilton, Conn.
Jillson, Benjamin Cutler, PH.B. MD., *al.* — Pittsburgh, Penn.
Prof. of Chem. Mineralogy and Geol. in Cumberland Univ. Tenn., and of Chem. and Geol. in West. Univ. of Penn.
Johnson, E. Emory, — East Haddam, Conn.
Johnson, Edward Whiting, — Norwich, Conn.
Johnson, Samuel William, M.A. — New Haven, Conn.
Prof. Analyt. and Agricult. Chemistry, Yale Coll.
Johnson, Rev. Wilbur, B.A. — Sandwich, Mass.
Johnston, James Grant, — Davenport, Iowa.

1859-62	Jones, George William, B.A. Professor in Iowa Agricultural College.	Ames, Iowa.
1856-9	Judd, Lyman Blakeslee,	New Haven, Conn.
1850-3	Judd, Orange, M.A. Wesl, Univ. Editor of the American Agriculturist.	New York City
1868-9	Judson, John Nichols,	New Haven, Conn.
1868-9	Keasbey, George Macculloh,	Newark, N.
1855-6	Kellon, Daniel M.	E. Bloomfield, N.
1857-8	*Kendall, John E.	Boston, Mass.
1866-9	Kendall, Joseph Goodhue,	New York City
1865-6	Kendrick, Thomas Meredith,	Waterbury Conn.
1855-7	Kent, Alexander Hamilton, PH.B. (Eng.)	New Orleans, La.
1862-3	Ketchum, Landon, PH.B.	New York City
1860-2	King, Clarence, PH.B. Chief of the U. S. Survey of the 40th Parallel.	New York City.
1849-50	King, George F.	Riceboro', Ga.
1856-8	King, Horace Kendall, PH.B.	Tully, N. Y.
1853-4	King, James T.	Middletown, N. Y.
1853-4	King, William H.	Liberty Co., Ga.
1862-3	Kirby, William J.	Cherry Valley, N. Y.
1847-50	*Kitchell, William, M.D. Univ. of N. Y. Geologist to State of New Jersey.	Morristown, N. J.
1857-9	Kittredge, Charles Stewart, B.P., C.E.	Nashua, N. H.
1868-9	Klein, Joseph Frederick,	New Haven, Conn.
1866-7	Knox, William,	Philadelphia, Pa.
1866-9	Koon, Charles Byron,	Auburn, N. Y.
1853-4	Koons, Isaac P	Norristown, Pa.
1866-8	*Lamport, Lewis Reed, PH.B., M.D. N. Y. Univ.	*1868. N. Y. City.
1855-6	Lancraft, Charles Elliott,	Fair Haven, Conn.
1850-1	Larkin, Ethan P (Supt. of Oil Works.)	Zoritos, Peru.
1867-8	Lawther, Samuel Dyer,	Fulton, Mo.
1862 5	Leavens, Francis Jedediah, PH.B. (Manufacturer.)	Norwich, Conn.
1858-9	*Lee, John Timothy, *1862-3.	Southington, Conn.
1849-50	Leffingwell, A. H.	New Haven, Conn.
1848-9	Leuchars, Robert B. (Landscape Gardener.)	Boston, Mass.
1856-7	Lewis, Rev John V., M.A. Columb. Coll.	Brooklyn, L. I.
1849-50	Linsley Edward T.	Meriden, Conn.
1863-6	Linsly, Wilford. (Artist.)	New York City.
1866-9	Littleton, Augustus Washington,	Peoria, Ill.
1868-9	Lobdell, George Granville,	Wilmington, Del.
1864-6	Loomis, Francis Englesby, B.A., PH.D.	New Haven, Conn.
1860-2	Lorillard, George Lyndes,	New York City.
1867-9	Lovell, William Mead,	Covington, Ky.
1867-9	Lowe, Francis Asbury,	Washington D. C.
1866-9	Lowe, Houston,	Dayton, O.
1851-2	Lowrey, Henry,	Southinglon Conn.
1865-6	Lucas, James Joseph, B.A. Cent. Coll. Ky., B. A. Yale,	Danville, Ky.
1852-3	Lufkin, Albert. (Eng.)	Newton, Iowa.

1858-9	*Lummis, Hiram Holt. M.D. *1860	Russelville, Ky.
1854-5	Lyle, George W., PH.B. (Eng.)	Athens, N. Y.
1867-8	Lyman, Frederick Gold,	Goshen, Conn.
1864-7	Lyman, George Richards,	Northampton, Mass.
1855-7	Lyon, William D.	Mobile, Ala.
1863-6	McAlister, Alexander Ufford, PH.B., (Editor)	New Haven Conn.
1852-3	McCabe, Michael,	New Haven, Conn.
1867-9	McCall, James Edward,	New York City.
1849-50	McCalmont, Robert, (Chem.)	Larne, Ireland.
1868-9	McClean, George Chestley,	Springfield, Mass.
1860-1	McCurdy, Henry Isaac, (Chem.)	Augusta, Ark.
1868-9	McDaniel, Joseph L.	Wilmington, Del.
1863-6	McDonald, James A., B.A. Columb.,	Flushing, N. Y.
1863-4	McGregor, James Clarence, PH.B. (Eng)	Cincinnati, O.
1865-8	McKell, Joseph Scott, PH.B.	Chillicothe, O.
1864-6	McLean, Charles Fraser, B.A. PH.D.	New Haven, Conn.
1862-3	*McRuer, William Henry, PH.B.	Bangor, Me.
1867-8	Maher, John Aloysius,	New Haven, Conn.
1864-5	Mallory, Charles,	Mystic, Conn.
1858-61	Manice, Edward Augustus, PH.B. M.A.	New York City.
1860-3	Manning. Henry Swan, (Merc.)	Brooklyn, N. Y.
1857-8	Marcy, William L.	Coventry, N. Y.
1867-9	Marks, William Dennis,	St. Louis, Mo.
1862-3	Marsh, Daniel S.	New London, Conn.
1860-2	Marsh, Othniel Charles, M.A. Prof. of Palaeontology, Yale Coll.	New Haven, Conn.
1857-8	Martin, Charles,	Philadelphia, Pa.
1863-4	Martin, Constantine H.	Allentown, Pa.
1855-7	Martin, David Bigum, PH.B (Eng.)	Keokuk, Iowa.
1859-61	Martinez, Salomé, PH.B. (Eng.)	Matanzas, Cuba.
1865-7	Mason, Thomas Henry, (Merc.)	New York City.
1862-5	Massey, Albert Parsons, PH.B.	San Francisco, Cal.
1847-8	Mather, Thomas S.	Simsbury, Conn.
1868-9	Mather, Thomas William,	New Haven, Conn.
1866-8	Mather, Wallace Ellingwood,	Andover, Mass.
1864-7	Matthias, John J., M.A. N. Y. Univ, PH.B. (Merc.)	New Haven, Conn.
1868-9	Maxson, Charles Clarence,	Waverly, R. I.
1868-9	Mead. Charles Durkey,	Dayton, O.
1860-2	Mead, Daniel Smith,	Greenwich, Conn.
1853-4	Mead, Solomon, (Agric. and Manuf.)	New Haven, Conn.
1854-7	Meade, G. Harrison, PH.B. (Eng.)	Holden, Mass.
1855-6	Megarey, Alexander H.	Brooklyn, L. I.
1861-3	*Megia, Ignacio M.	Oaxaca, Mexico.
1868-9	Merriman, Mansfield,	Plantsville, Conn.
1852-3	Messer, Moses H. (Eng.)	Onarga, Ill.
1866-7	Miles, Frank Lawrence,	Elkhart, Ind.
1868-9	Miles, William Augustus,	Salisbury, Conn.
1849-50	*Miller, George R.	Louisville, Ky.
1855-6	Miller, José,	Chocó, N. Granada.

1863–5	Millikin, Dan, (Agric.)	Hamilton, O.
1863–4	Mitchell, William J.	Albany, N. Y.
1864–9	Mixter, William Gilbert, PH.B. (Chem.) Assistant in Chemistry.	Rock Island, Ill.
1866–7	Möller, Alexander,	Mineral Point, Wis.
1849–50	Moffat, Daniel C.	Chester, N. Y.
1868–9	Moore, Alfred Louis,	Fond du Lac, Wis.
1861–2	Moore, Benjamin F.	Cutchogue, N. Y.
1859–62	Moore, Gideon Emmet, PH.B. (Chem.) Assayer to the Gould & Curry Mining Co., Virginia City.	San Francisco, Cal.
1852–3	Moore, Ira, PH.B. (Chem.)	Bridgewater, Mass.
1854–6	Morehouse, Louis Peck, PH B. (Eng.) Asst. Eng. on the Illinois Cent. R. R.	New Haven, Conn.
1862–4	Morris, Henry L.	New York City.
1855–6	Morris, James S.	Morrisania, N. Y.
1868–9	Morton, Joseph Lewis,	New York City.
1852–5	Mosman, Alonzo Tyler PH.B. Assist. in U. S. Coast Survey.	Brookfield, Mass.
1866–7	Mott, Wallace. (U. S. Mil. Acad.)	Roslyn, L. I.
1850–1	Munson, Alfred,	New Haven, Conn.
1849–50	Murray, George Crawford, M.A. (Agric.)	Middletown, N. J.
1855–6	Nash, Joseph N.	Petersburgh, Va.
1865–9	Needham, Charles Kinney, PH.B.	Louisville, Ky.
1866–9	Nelson, Edward T., B.A. Ohio Wesl. Univ.	Galion, O.
1866–7	Niles, William Harmon, PH.B.	Southampton, Mass.
1852–3	Niles, William W. B.A. Princeton,	North Haven, Conn.
1869–8	Noonan, Frederick George, PH.B.	Milwaukee, Wis.
1847–9	Northrop, James R. (Chem.)	Manchester, Conn.
1859–60	Norton, Charles Ledyard, B.A.	New York City.
1856–7	Noyes, George Edward,	Byfield, Mass.
1858–9	Oberly, Aaron Skinner, M.D.	Easton, Pa.
1854–5	Olcott, James,	Manchester, Conn.
1859–61	Olds, Glaucus Evans,	Hillsboro', N. C.
1849–53	*Olmsted, Alexander Fisher, M.A. (Chem.) *1853	New Haven, Conn.
1854–5	Ortiz, Pedro P.	Valparaiso, Chili.
1852–3	Palen, Gilbert Ezekiel, PH.B. (Eng.)	Saugerties, N. Y.
1863–7	Palmer, Alexander Smith, PH.B.	Stonington, Conn.
1861–2	Palmer, Charles J.	Danville, Ill.
1866–7	Pardee, Julius Hayden,	Oswego, N. Y.
1847–8	Parke, Francis G.	Coatsville, Pa.
1864–7	Parmelee, George Fowler, PH.B.	New Haven, Conn.
1865–8	Parshall, Lyman Bradley, PH.B.	Farmer, N. Y.
1853–4	Parsons, David Ball, PH.B. (Eng.)	Hoosac Falls, N. Y.
1855–6	Parsons, Robert L.	Pittsfield, Mass.
1860–2	Parsons, Samuel, PH.B. (Agric.)	Tom's River, N. J.
1864–5	Patterson, Joseph Nelson,	Pittsburgh, Pa.
1853–4	Pease, Walter B., B.A. Miami Univ.	Dayton, O.
1859–61	Percival, George G., B.A. Waterville, M.D. *al.* (Drug.)	Philadelphia, Pa.

3	Perkins, Rev. George A., M.A. Bowd. Professor in Robert College, Constantinople.	Constantinople, Turkey.
9	Perkins, George Henry, B.A.	New Haven, Conn.
5	Perkins, John McC.	Somersworth, N. H.
9	Perry, Henry Hoyt,	Southport, Conn.
1	Phillips, J. Augustus, M.D. Univ. Penn.	Pittsburg, Pa.
5	Phinney, Arthur, B. A.	Gorham, Me.
1	Pickard, Thomas, (Teacher.)	Lackville, N. B.
9	Pierce, David F.	South Britain, Conn.
4	Pierce, John, M.A. Brown Univ.	Providence, R. I.
3	Pierce, William Edward,	Raleigh, N. C.
3	Pierce, William Tuston,	Wilmington, Del.
9	Pierpont, David Hobart,	North Haven, Conn.
4	Pierson, George Bowen, PH.B.	New York City.
5	Pierson, Stephen Condit, B.A. (Eng.)	Hartford, Conn.
7	Pike, William Henry, PH.B. (Eng.)	Mattituck, L. I.
3	Plata, Isidro, PH.B.	Bogota, N. Granada.
3	Platt, Lucien Tudor,	Waterbury, Conn.
3	Pombo, Fidel, B.P.	Bogota, N. Granada.
9	Pope, Charles Henrique,	Louisville, Ky.
5	Porter, Charles Hogeboom, M.A. M.D. Alb. Prof. of Chem. and Med. Jurisprud. in Albany Medical College, N. Y.	Albany, N. Y.
6	Porter, Henry C.	Oxford, N. Y.
30	Porter, Joseph,	Higganum, Conn.
8	Post, Charles Harvey,	Guilford, Conn.
9	Powell, Ferdinand Eugene,	Chester Springs, Pa.
5	Powell, Henry T.	Milford, Conn.
60	Powell, William Devans,	Newport, R. I.
2	Prouty, Jonas G.	Spencer, Mass.
7	Pumpelly, George Brinckerhoff, (Manufac.)	Owego, N. Y.
8	Pumpelly, James,	Owego, N. Y.
9	Quigley, John Franklin,	Wilmington, Del.
5	Randall, John West,	Annapolis, Md.
9	Ranger, John Hillard,	Norwich, Conn.
1	Raymond, Carrington Howard, PH.B. (Eng.)	Brooklyn, N. Y.
3	Redfield, William Wallace, PH.B. (Eng.)	Philadelphia, Pa.
5	Reeve, Henry Willis, (Merc.)	Brooklyn, N. Y.
8	Renick, Alexander, PH.B.	Chillicothe, O.
3 7	Reynolds, William A., M.A. Yale and Trin.	Paris, France.
9	Rice, Arthur Woods,	West Meriden, Conn.
60	Rice, Julio Alberto,	Parral, Mexico.
7	Rice, Rev. William North, M.A. Wesl., PH.D. Professor of Geology, etc., in Wesleyan University.	Middletown, Conn.
7	Richards, Selden Silliman, PH.B. (Eng.)	New York City.
8	Riotte, Walter Charles,	Costa Rica, Costa Rica.
9	Roberts, Evelyn Pierpont,	New Haven, Conn.
5	Robinson, Ebenezer T.	Pomfret, Conn.
5	Robinson, Sanford, PH.B. (Eng.)	New York City.

1855–7	Rockwell, Alfred Perkins, M.A. PH.B. (Mining Eng.) Prof. of Mining in Yale Coll. and in the Mass. Inst. of Technology.	Boston, Mass.
1865–6	Rockwell, John Arnold,	Norwich, Conn.
1865–8	Rockwell, Joseph Perkins, PH.B.	Norwich, Conn.
1864–6	Rockwood, Charles Greene, B.A. PH.D. Professor of Physics in Bowdoin College.	Newark, N. J.
1865–8	Rodman, Charles Shepard, M.D.	Waterbury, Conn.
1862–4	Roffe, Albert, PH.B. (Eng.)	Newton Centre, Mass.
1852–4	Rogers, Albert Bowman, PH.B. (Eng.)	Providence, R. I.
1862–5	Rogers, Harry,	Philadelphia, Pa.
1858–61	Rogers, Joseph Addison, PH.B. C.E. Assistant in the Hydrographic Bureau, U. S. Navy Dept.	Washington, D. C.
1868–9	Rogers, William Augustus, M.A. Brown, Prof. in Alfred Univ.	Alfred Centre, N. Y.
1852–4	Rood, Ogden N., M.A. Coll. of N. J. Prof. of Physics in Columbia Coll.	New York City.
1867–9	Roseberry, George Douglass,	Pottsville, Pa.
1868–9	Rowland, Henry Augustus,	Newark, N. J.
1855–7	Russell, David Moore,	Gainesville, Ala.
1858–9	*Russell, S. Wadsworth, *1868	Middletown, Conn.
1850–1	Sabin, Daniel,	New Haven, Conn.
1856–68	*Sackett, Edward, PH.B.	Warren, Conn.
1847–8	Safford, James M., M. A. Ohio Univ., PH.D. (Hon.) Geologist to State of Tenn.; Prof. of Chemistry, etc., in Cumberland Univ., Tenn.	Lebanon, Tenn.
1856–7	St. John, Benjamin,	Darien, Conn.
1853–5	St. John, Howell W., PH.B. (Eng.)	Bridgeport, Conn.
1854–5	St. John, James E.	New Canaan, Conn.
1852–3	Salter, John Cotton, (Agric.)	Waverly, Ill.
1853–5	Sanderson, Howard,	Athens, N. Y.
1859–61	Sands, Joshua, PH.B.	Stratford, Conn.
1868–9	Sanford, Frederick Lockwood,	New Haven, Conn.
1868–9	Sargent, Henry Bradford,	New Haven, Conn.
1859–61	Schuyler, Eugene, B.A., PH.D., LL.B. Col. U. S. Consul in Moscow.	New York City.
1857–8	Searles, William H. (Eng.)	Cincinnati, O.
1857–9	Seely, George Dallas, PH.B.	Honesdale, Pa.
1854–6	Seely, Henry Martyn, PH.B., M.A., M.D. Berks., Prof. of Nat. Science in Middlebury Coll.	Middlebury, Vt.
1853–4	Selden, Flavel C.	New Haven, Conn.
1847–8	Selden, Silas Richards, M.A.	New Haven, Conn.
1849–50 1855–7	Selden, William,	New Haven, Conn.
1861–5	Semple, Frank, (Manufac.)	Pittsburgh, Pa.
1859–60	Sheafer, Walter S., PH.B. (Eng.)	Pottsville, Pa.
1864–8	Sheffield, Charles Joseph, (Merc.)	Cleveland, Ohio.
1850–2	Shepard, Wm. Arthur, PH.B.	Dorchester, Mass.
1852–3	Sherman, John R.	Westerly, R. I.
1861–2	Shoemaker, Frank L.	Wyoming Valley, Pa.
1867–9	Shoenberger, Peter,	Cincinnati, O.
1855–6	Sizer, Henry S.	Buffalo, N. Y.

1850–1	Skeel, Almet,	Brooklyn, N. Y.
1863–6	Skeel, Theron, PH.B., C.E. Assist. Engineer U. S. Navy.	Newburgh, N. Y.
1863–5	Skiddy, William W. (Merc.)	Stamford, Conn.
1866–9	Skinner, Joseph John,	Wallingford, Conn.
1848–9	Smith, Edmond Reuel, B.A. Georgetown, D. C.	New York City.
1857–9	Smith, George Hazard, PH.B.	New London, Conn.
1855–6	Smith, James E.	Petersburg, Va.
1866–7	Smith, Jay Wilson,	Loda, Ill.
1855–6	Smith John B.	E. Hartford, Conn.
1869–9	Smith, Sidney Irving, PH.B. (Zoölogist.) Assistant in Zoology.	New Haven, Conn.
1894–5	Smyser, Benjamin R.	New Haven, Conn.
1852–3	Sparrell, E. Kirkwood, PH.B.	Medford, Mass.
1857–9	Sparrow, Orson Cowles, B.A., PH.B., M.D., L. I.	New York City.
1859–60	Spencer, William H. (Agric.)	Geneseo, N. Y.
1854–5	Spier, Robert F.	Brooklyn, L. I.
1861–2	Squier, Stuart C. (Merc.)	Rahway, N. J.
1848–51	Stadtmuller, Ludwig, PH.B. (Hon.) (Min. Eng., etc.,)	W. Hartford, Conn.
1867–9	Stanton, Alfred,	Sligo, Md.
1852–3	Starr, Frederick E.	New Milford, Conn.
1858–9	Stebbins, Charles H. (Merc.)	New York City.
1860–2	Sterling, Clarence,	Bridgeport, Conn.
1864–5	Sterling, John William, B.A.	Stratford, Conn.
1864–5	Sterling, Julian Henry,	Bridgeport, Conn.
1860–1	Stevens, Charles Dibbell,	Clinton, Conn.
1853–4	Stevens, Joseph T. (Merc.)	Brooklyn, L. I.
1868–9	Stickney, Frank Hale,	Rockville, Conn.
1852–3	Stiles, T. Augustine,	Salisbury, Conn.
1863–5	*Stone, Adelbert Barnes, *1865	Cleveland, O.
1862–4	Stone, Courtland B. (U. S. Coast Survey.)	New Milford, Conn.
1866–8	Stone, George Frederick,	Hartford, Conn.
1861–2	*Stone, Henry V. D.	Brookline, Mass.
1863–7	Stone, James Bennett, PH.B., C.E. (Eng.)	Boonton, N. J.
1865–8	Stone, Lewis Bridge, PH.B.	New York City.
1866–7	Stone, William, B.A.	Croton Falls, N. Y.
1866–7	Stowell, Franklin Wallace, (Merc.)	Brooklyn, N. Y.
1867–8	Strong, Moses, B.A.	Mineral Point, Wis.
1863–4	Struthers, Thomas E.	Warren, Pa.
1850–1	Stuart, Charles B. Professor in Randolph-Macon Coll., Va.	Boydton, Va.
1864–5	Sturges, Abram B.	Plymouth, Conn.
1865–8	Swift, Samuel, PH.B.	East Hampton, Mass.
1866–8	Swinburne, Henry Herbert,	Newport, R. I.
1865–7	Tainter, Charles Emory,	Worcester, Mass.
1853–4	Tallon, John E., M.D. *al.*	New Haven, Conn.
1854–5	Taylor, John H.	Glastenbury, Conn.
1865–6	Taylor, John Jacob,	Newport, R. I.

1853–4	Taylor, William J. M.D. Professor in the Medical College, Mobile, Ala.	Philadelp
1858–9	Teed, J. S., M.D. *al.*	Men
1852–56	Terry Adrian, B.A., PH.B. (Civ. Eng.) Engineer of the Knoxville and Louisville Railroad.	Knoxville
1868–9	Terry, Edward Clinton,	Terryville
1864–7	Terry, Frederick, (Eng.)	Knoxville
1863–6	Thomas, Frederick F., B.A., PH.B. (Assayer.)	Silver Peak, N
1860–1	*Thompson, John Hanson, (*1863)	New Yo
1852–3	Thompson, Samuel E.	Dorchester
1863–5	Throckmorton, Samuel R., B.A.	San Francis
1861–2	Thurston, William R.	New Yo
1862–4	Tiffany, Henry D. (Merc.)	West Farms
1858–60	Torrey, Robert N.	Honesd
1848–9	Townsend, William,	New Haven
1863–5	Treadwell, John H.	New Yo
1848–9	Treat, Joseph H.	Tallma
1864–6	Trump, Franklin,	Jersey Sh
1849–50	Tuttle, John W.	New Haven
1852–3 1856–7	Twining, Edward H., M.A. Wab. Professor in the Minnesota University.	
1856–9	Twining, Sutherland Douglas, PH.B., M.D.	Chic
1860–1	Tyson, Samuel Traquair,	Prince of Prus
1850–1	Upham, James P.	Claremont
1866–7	Upton, Clarence Hawkins,	Rochester
1850–2	Uricoechea, Ezequiel, M.D., PH.D. Gött. Professor of Natural Science in the Univ. of Bogota.	Bogota, N. G
1864–5	Van Deventer, William H.	Astoria
1862–4	Van Harlingen, Arthur, M.D. Univ. Penn., Resident Phys. Philadelphia Hosp.	Philadelpl
1861–4	Van Harlingen, Martin, Assist. Eng. Camden & Amboy R. R.	Bordentown
1856–7	Vanleer, Rush,	Nashville
1866–7	Van Rensselaer, Robert Schuyler,	Bordentown
1853–4	Vasquez, Uladislao,	Medellin, N. G
1853–5	Vengohechea, Onofre, PH.B. (Merc.)	Santa Marta, N. G
1857–9	Wadsworth, Craig W. (Agric.)	Geneseo
1864–6	Wadsworth, Wedworth, (Merc.)	New Yo
1868–9	Wakeman, Harwood,	New Yo
1853–5	Walcott, George D., PH.B. (Eng.)	Detroit
1856–7	Walker, Charles H.	Pearl Creek
1868–9	Wallace, Shippen,	Philadelpl
1847–8	Walter, John J	Hamden
1861–2	Ward, Hubert C.	Farmington
1856–7	Ward, William H., B.A. Amh.	Abington
1849–50	Waring, James J., B.A., M.D. Univ. Penn. Professor in the Medical College, Washington.	Washingto
1862–3	Warner, Charles K.	New Yo
1849–50	Warner, Richard S.	Middletown
1868–9	Warren, Clarence Augustus,	Louisvil

1864–8	Warren, William Y. (Iron Master.)	Buffalo, N. Y.
1867–9	Watson, John George,	Ayr, C. W.
1854–6	Watson, Matthew, PH.B.	Nashville, Tenn.
1866–7	Watson, Sereno, M.A. (Botanist.)	Hartford, Conn.
1861–2	Way, Albert L.	Philadelphia, Pa.
1848–9	Webster, George Gideon, M.A. LL.B.	San Francisco, Cal.
1868–9	Webster, Harrison Edwin, B.A. Union Coll.	Schenectady, N. Y.
1866–9	Weed, Charles Alvah,	Binghamton, N. Y.
1853–4	Weems, John W.	Alexandria, La.
1848–53	Weld, Mason Cogswell, PH.B. (Hon.) (Chem.) Assistant Editor of the American Agriculturist.	New York City.
1864–8	Wells, Daniel Halsey, PH.B. C.E. Assistant in Engineering, Yale Coll.	Upper Aquebougue, N. Y.
1861–2	West, William Frederick, B.A. N. Y. F. Acad. (Manf.)	Brooklyn, N. Y.
1849–52 1855–57	*Weyman, George Washington, B.P. PH.D. Gött.	*1864 Pittsburg, Pa.
1865–6	Wheeler, Benjamin Pomeroy,	North Stonington, Conn.
1854–8	Wheeler, John Davenport, PH.B. (Manufac.)	New Haven, Conn.
1866–7	White, William Clarke,	Rochester, N. Y.
1865–9	White, William Robert,	Philadelphia, Pa.
1866–9	Whitman, Horace Franklin,	Philadelphia, Pa.
1849–50	Whitman, John,	West Hartford, Conn.
1863–5	Whitman, John L.	Westerly, R. I.
1862–3	Whiton, John Milton,	Worcester, Mass.
1862–7	Whittelsey, Joseph Thompson, PH.B. (Merc.)	New Haven Conn.
1866–9	Wight, Willard Wendell,	Natick, Mass.
1861–2	Wilcox, Edward P.	Waioli, Sandwich Isl.
1860–2	Wilcox, George Norton,	Waioli, Sandwich Isl.
1853–5	Wilcox, Thomas A. PH.B.	W. Granby, Conn.
1867–8	*Wilcox, William Bartlett,	Portland, Conn.
1856–7	Wilkeson, Samuel H.	Buffalo, N. Y.
1848–9	Willett, Joseph E., M.A. Mercer Univ. Ga. Prof. of Nat. Sciences, Mercer Univ. Georgia.	Penfield, Ga.
1866–9	Willetts, Frederick Everett,	Glen Cove, L. I.
1854–5	Williams, Dwight L.	Hartland, Conn.
1865–8	Williams, Henry Shaler, PH.B. Assistant in Palæontology, Yale Coll.	Ithaca, N. Y.
1854–6	Williams, John L.	Clayton, Ala.
1854–6	Williams, Lewis, PH.B. (Eng.)	Cleveland, O.
1858–9	Williamson, Andrew W., B.A. Marietta,	Pajutazee, Minn.
1855–6	Willson, A. Duncan,	Canandaigua, N. Y.
1850–1	Wing, James G.	Albany, N. Y.
1847–9	*Wing, Matthew Gregory, M.A. (*1860)	Albany, N. Y.
1854–5	Wing, Yung, B.A.	Macao, China.
1853–5	Wingfield, George,	Washington Ga.
1864–5	Wires, Rodney S.	Burlington, Vt.
1848–9	Withington, James H., M.A. Waterville. (Teacher.)	Hallowell, Me.
1866	Wolcott, Gardiner Howland,	Astoria, N. Y.
1864–7	Wood, Luther Hodges, PH.B, M.D. (Druggist.)	New Haven, Conn.
1853–4	Wood, William L. M A.	Charlotteville, N. Y.

1855–6	Woodbridge, Rev. William Reed, M.A.	Marbleh
1868–9	Woodward, Richard William, B.A.	Frank
1862	Woolsey, William Walton, (Merc.)	New Y
1859–61	Wright, Arthur W., B.A. PH.D.	Williamsto
	Tutor and Instructor in Physics, Yale Coll.; Prof. of Physics, Will	
1852–3	Wright, Leonard,	Hoosick Fa
1856–7	Yeomans, Williams H.	Columl
1860–1	Youmans, William J.	Saratc
1856–7	Ysalgué, Alfonso,	Santia
1865–6	Zabriskie, F. H.	New Hav
1868–9	Ziegler, Harry Degen,	Philade

ADDITIONS.

1868–9	Crane, Robert F.	New Hav
1868–9	Fulton, William H.	New Hav
1868–9	Harger, Oscar, B. A.	Oxfc
1868–9	Verrill. Edgar,	No
1868–9	Wheeler, Samuel, B. A.	Bridgep

SUMMARY.

Doctors of Philosophy,	
Civil Engineers,	
Bachelors of Philosophy,	1
Whole number of Students,	6

PROGRAMME OF STUDIES.

OBJECT.

The Sheffield Scientific School of Yale College provides for young men instruction in the various branches of physical, natural and mathematical science, in the French and German languages, and other studies. Scholars are received for the regular course of instruction extending through three years, or for special advanced courses, corresponding with their respective wants and requirements. Those who have not already taken a college degree, will commonly find it advantageous to enter at the beginning of the Freshman year. Those who have already graduated as Bachelors of Arts or Science, and those who have otherwise fitted themselves for advanced studies, may enter at once upon special courses, having immediate reference to their professional training.

ORGANIZATION.

This institution has been constituted by the Legislature, the Connecticut college for the promotion of Agriculture and the Mechanic Arts, and as such has received the benefit of the land appropriation bestowed by Congress upon this Commonwealth. As a department of Yale College it shares in the libraries, museums, and other advantages which pertain to that long established seat of learning. Private generosity, especially the munificence of Mr. Joseph E. Sheffield, has provided additional facilities for the prosecution of scientific studies.

The care of the institution is intrusted, under the President and Fellows of Yale College, to a Governing Board of thirteen professors, who are also the instructors of the school, each of them representing some department of learning. Several assistants are also employed.

The regular courses of study are arranged in seven sections, as follows:

I. Chemistry and Mineralogy; II. Civil Engineering; III. Mechanics; IV. Mining and Metallurgy, (advanced course); V. Agriculture; VI. Natural History and Geology; VII. Select Course in Science and Literature.

The arrangements of all these sections are fully exhibited below.

BUILDING AND APPARATUS.

Sheffield Hall, in which most of the instruction is given, is a large and well arranged building containing recitation and lecture rooms for all the departments of the school, a hall for public assemblies and lectures, a drawing room for the engineering class, laboratories for chemical and metallurgical investigations, a photographical room, an astronomical observatory, a museum, a library and reading room, besides studies for some of the professors, where their private technical libraries and collections are kept.

The arrangements of Sheffield Hall, and also the various collections of the School and of the College (so far as the latter are applicable to this department), were described in the report for 1866–7.

APPARATUS OF INSTRUCTION.

The following is a summary statement of the material possessions applicable to the purposes of instruction:

I. *Pertaining to Sheffield Hall.*

1. Laboratories in Chemistry, Metallurgy, Mechanics, Photography and Zoology.
2. Metallurgical Museum of Ores, Furnace Products, etc.
3. Agricultural Museum of Soils, Fertilizers, useful and injurious Insects, etc.
4. Astronomical Observatory, having a very good equatorial telescope, by Clarke & Son, of Cambridge, a meridian circle, etc.
5. A library and reading room, containing books of reference and a selection of German, French, English and American scientific journals.
6. A collection of models in Architecture and Civil Engineering.
7. A collection of Maps and Charts, topographical, hydrographical, geological, etc.
8. The private mineralogical cabinet of Prof. Brush, the herbariums of Professors Eaton and Brewer, the collection of native birds of Professor Whitney, the astronomical instruments of Professor Lyman,—all freely accessible to qualified students.
9. A collection of apparatus and models in Physics and Mechanics, to which large additions are to be made during the coming year. (v. p. 14.)

II. *Pertaining to the University.*

1. The College Library, consisting of 50,000 volumes, and the Society Libraries, consisting of 26,000 volumes; TOTAL, 76,000 volumes.
2. Two Reading Rooms, one containing the newspapers and literary journals of England and the United States;—the other, quarterlies and monthlies in various languages and departments of learning.
3. The Cabinet of Minerals and Fossils,—an extensive and well known collection.
4. The Collections in Natural History.
   (These collections and the mineral cabinet will be removed to the Peabody Museum when it is built; a fund of $150,000 having been given for this purpose by Geo. Peabody, Esq., of London).
5. Apparatus in Physics and Chemistry, adapted to and employed in public lectures.

6. The Collections of the Yale School of the Fine Arts, including the well known "Jarves collection" of early Italian paintings, and a selection of casts from the antique.
7. A Gymnasium for physical training.

CLASSIFICATION OF THE STUDENTS.

The pupils of the scientific school are thus classified:

1. Those who are pursuing a systematic and prescribed course of study, extending through three years, and leading to the degree of Bachelor of Philosophy;

2. Those who have already been admitted to the degree of Bachelor of Philosophy, Science, or Arts, and are pursuing an advanced course of study leading to the degree of Doctor of Philosophy, or in some cases to the degree of Civil Engineer;

3. Special students, who have already made a certain degree of proficiency in some department of science, and are now pursuing special scientific studies under the personal direction of some of the professors.

DEGREES.

The degrees below named are conferred by the Corporation of Yale College on students who have passed the required examinations at the close of their course, and are recommended as candidates by the Governing Board of the School:

1. Bachelor of Philosophy, conferred at the termination of three years' study in any one of the several sections of the School;

2. Doctor of Philosophy, conferred on those who have already been admitted to the degree of Bachelor in Philosophy, Science, or Arts (in this or any other college), and who successfully pursue in this college a higher course of study, extending through two years.

3. Civil Engineer, conferred on students of the engineering section who have already taken the degree of Ph.B., and subsequently pursue with success the higher course of engineering;

4. In addition to the diploma of the Corporation, the instructors will give, if requested to do so, a formal certificate, stating how long the student has been a member of the institution, and in what department of study he is proficient. This certificate will be awarded only to meritorious students, after a thorough examination, and will be considered as the personal recommendation of the professors who sign it.

CONDITIONS OF ADMISSION; AND OF GRADUATION.

All applicants for admission must be not less than sixteen years of age, and must bring satisfactory testimonials of good character.

The regular examinations for admission take place at Sheffield Hall, on the Tuesday preceding Commencement (Tuesday, July 20, 1869), at 8 A. M., and eight weeks later, on that Wednesday in September (Wednesday, Sept. 15) on which the fall term begins. Opportunity for private examination may, in exceptional cases, be given at other times.

1. TO THE REGULAR THREE-YEAR COURSES AS CANDIDATES FOR THE DEGREE OF PH.B.

Students desiring to go through any one of the prescribed three-year courses of the school, as candidates for the degree of Bachelor of Philosophy, must be prepared as follows:

The examination is of a two-fold character, first to ascertain the mathematical attainments of the candidate; and second to ascertain his general literary culture. It is requisite for admission that the student should be thoroughly prepared in both respects. As an incitement to diligence, a prize of twenty dollars is offered to the person who shall pass the best entrance examination in 1869.

In Mathematics, an acquaintance is required with *Arithmetic*—including the Metric System of Weights and Measures; *Algebra*—as far as the General Theory of Equations; *Geometry*—Davies's Legendre; and *Plane Trigonometry*, including the *Analytical* section in Davies, or Loomis.

The English studies on which students are examined are, the Elements of Grammar, United States History, and Geography.

In Latin, an acquaintance with six books of Virgil, or with an equivalent amount in some other author, and a familiarity with the Grammar, (or so much of it as is given in Allen's "Manual Latin Grammar") will henceforward be required.

Candidates for advanced standing in the three regular classes are examined, (unless already graduates,) in addition to the preparatory studies, in those already pursued by the classes they propose to enter. No one can be admitted as a candidate for the degree of Ph.B. after the commencement of the Senior year.

A graduating thesis is required at the close of this course from all candidates for the degree.

2. TO SPECIAL COURSES.

Students who are not candidates for a degree, and who propose to pursue some special department of study, are not required to pass an examination for admission; but are expected to furnish the *Professor* with whom they are enrolled, satisfactory evidence of *their capacity* to profit by the proposed instruction.

For pursuing special courses of study in the various branches of practical chemistry, including metallurgy, the Analytical Laboratory affords convenient facilities. In Zoölogy also and other branches of natural history, special students can be conveniently received. Instruction will likewise be given in Practical Astronomy and the use of the instruments. But there is no opportunity in this institution for young men to select, in an aimless manner, here a little and there a little, from the instructions which are provided. Those who determine to pursue the Select Course, laid down in the programme, are expected to give their attention to all its studies.

3. TO HIGHER COURSES, AS CANDIDATES FOR THE DOCTORATE OF PHILOSOPHY.

Young men who have already taken a Bachelor's Degree in Arts, Philosophy or Science, may pursue a course of advanced studies under the direction of the Faculty of Philosophy and the Arts, and at the expiration of two years may receive the degree of Doctor of Philosophy, upon passing the requisite examinations. Such candidates must reside in New Haven during the academic terms of two years, and must present at the close a thesis giving evidence of high attainment in the studies pursued. The course may be selected wholly from the studies taught by the Professors in the Scientific School, or partly from them and partly from such as are taught by the other Professors in the Philosophical Department.

TERMS AND VACATIONS.

The College "Commencement" is held on the last Thursday but one in July of each year. The first term begins eight weeks from the day before Commencement and continues fourteen weeks; the second begins on the first Wednesday in January and continues fourteen weeks; the third, of twelve weeks, begins, this Collegiate year, on the last Wednesday in April and continues till Commencement. The intervening periods, of eight, two, and two weeks, are assigned for vacations.

The graduating exercises of the Scientific School take place on the Monday (July 19, 1869) before the public Commencement.

TUITION.

The charge for tuition is $125 per year, payable $45 at the beginning of the first and of the second term, and $35 at the beginning of the third term. The special student of Chemistry also pays the additional charge of seventy-five dollars per annum for

chemicals, and for use of apparatus. He will also supply himself at his own expense with gas, flasks, crucibles, &c., the cost of which should not exceed five or ten dollars per term.

The fee for graduation as Bachelor of Philosophy, including the charges for Triennial Catalogues, College Dinners, etc., is ten dollars. A fee of five dollars per year is also charged for the use of the College Gymnasium and Reading Room, and the Freshman class pays a small sum for the chemicals employed in the laboratory practice.

LECTURES.

Annual courses of lectures are given on the following topics:

FIRST TERM.

On Metallurgy, by Prof. BRUSH.
On Practical Agriculture, by Prof. BREWER.
On Agricultural Chemistry and Physiology, by Prof. JOHNSON.
On the History of Language and Linguistic Ethnology, by Prof. WHITNEY.
On Entomology, by Prof. VERRILL.
On Military Science by Gen. ROBERTS.
On the Physical and Historical Geography of Europe, by Prof. GILMAN.

SECOND TERM.

On the Strength of Materials, by Prof. NORTON.
On Metallurgy (continued), by Prof. BRUSH.
On Practical Agriculture (continued), by Prof. BREWER.
On Agricultural Chemistry and Physiology (continued), by Prof. JOHNSON.
On the Outlines of General Comparative Geography, by Prof. GILMAN.
On Botany, by Prof. EATON.
On Structural and Systematic Zoology, by Prof. VERRILL.
On Military Science, by Gen. ROBERTS.
On the History of Language and Linguistic Ethnology (continued), by Prof. WHITNEY.
On the Principles of Mechanism, by Prof. LYMAN.

THIRD TERM.

On Systematic Mineralogy, by Prof. BRUSH.
On Economic Mineralogy and Petrology, by Prof. BRUSH.
On Rural Economy and Farm Management, by Prof. BREWER.
On Structural and Systematic Zoölogy (continued), by Prof. VERRILL.
On the Steam Engine, by Prof. LYMAN.

A course of public evening lectures is also given.

EXAMINATIONS.

Oral examinations are held at the close of every term on the studies of the term, and written examinations are held every year on the studies of the year.

COURSES OF STUDY.

All who are candidates for the degree of Bachelor of Philosophy are expected to pass through the same course of instruction in the first year of their connection with the institution, unless they are admitted on examination to an advanced standing. The studies of Freshman year are those which are regarded as an important basis for all the higher instructions of the school. This introductory course includes a continuance of the mathematical studies required for admission, the general principles of Chemistry and Physics, the commencement of German, practice in English composition and Elocution, Surveying and Drawing,—as will be seen in the following outline. Near the close of Freshman year, every student is required to announce his selection of one of the higher courses of study,—and he is not allowed to change after the beginning of the second or Junior year without permission specially granted by the Governing Board.

FRESHMAN YEAR.

INTRODUCTORY TO ALL THE SECTIONS OF THE SCHOOL.

FIRST TERM.

Mathematics—Davies's Analytical Geometry. Spherical Trignometry. Surveying. *Physics*—Silliman's Principles. *English Language*—Exercises in Composition. *Chemistry*—Recitations and Lectures. *German*—Woodbury's Method and Reader.

SECOND TERM.

English—Rhetoric. Practical Exercises in Elocution. *German*—Woodbury Continued. Selections from approved authors. *Physics*—Silliman's Principles and Academical Lectures. *Chemistry*—Recitations and Lectures. *Mathematics*—Descriptive Geometry and Geometrical Drawing.

THIRD TERM.

English—Exercises in Composition. *German*—Selections. *Physics*—Silliman's Principles and Academical Lectures. *Chemistry*. *Mathematics*—Principles of Perspective. *Botany*—Gray's Manual. *Drawing*—Free Hand Practice.

JUNIOR AND SENIOR YEARS.

During the last two years of the course the students are instructed in separate sections, the particular arrangements of which may be found below. Each section is under the charge of special professors, with the exception of the Select Course, which is under the general charge of the Governing Board. To a consid-

erable extent the students of the several sections recite together. The study of French is commenced in the Junior year, and is required of all the students.

I. Chemistry and Mineralogy.

[Under the direction of Professors JOHNSON and BRUSH; Chemical Laboratory, Sheffield Hall, West Wing.]

The Sheffield Laboratory is fitted up in a complete and convenient manner, is provided with all the requisite apparatus and instruments of research, possesses a considerable collection of chemical preparations, and a consulting Library of the best treatises on Chemistry and the Chemical arts. It affords facilities for instruction in the various branches of theoretical and practical Chemistry.

Theoretical and Descriptive Chemistry are taught throughout the whole of the Junior year by lectures and by recitation,—Eliot and Storer's Manual and Miller's Elements being employed as text-books. The lectures of Professor Silliman to the Academical and Medical Classes are also accessible to the Senior Students. Every autumn term a class recites from Fresenius's Qualitative Analysis. Extended courses of Lectures on Agricultural and Metallurgical Chemistry are given yearly.

Mineralogy is taught in the Junior Year by lectures, which are fully illustrated with hand specimens and models, and by weekly exercises throughout the Senior Year in the identification of minerals from physical and chemical characters.

The Laboratory is open for Chemical Practice seven hours daily, except on Saturday, when it is closed in the afternoon. The student repeats a large number of experiments from Eliot and Storer's Manual, and works through a course of qualitative and quantitative analysis, which is varied according to his capacity and the object he has in view. Each pupil proceeds by himself independently of the others, under the constant guidance of the Instructors.

In connection with the department of Mining and Metallurgy, especial attention is given to assaying and the investigation of ores and furnace products. The student in Agriculture has opportunity to acquaint himself with the modes of research employed in agricultural chemistry. The applications of the science to other branches of industry are taught as occasion requires.

The systematic course likewise includes instruction in Zoölogy, Botany, Geology, and the French and German languages, as will be seen from the following programme:

FRESHMAN YEAR (see page 63).

JUNIOR YEAR.

Inorganic Chemistry—Eliot and Storer's Manual, Recitations and Lectures. *Analytical Chemistry*—Fresenius. Recitations and Lectures. *Laboratory Practice*—Repetition of Experiments from Eliot & Storer's Manual. Systematic Qualitative Analysis. Use of the Blowpipe. Quantitative Analysis. *Mineralogy*—Dana's System, Lectures and Practical Exercises. *Botany*—Gray's Manual, Excursions and Preparation of Herbarium. *Zoölogy*—Lectures and Excursions. *French and German* (see Select Course).

SENIOR YEAR.

General Chemistry—Academical and Medical Lectures. *Agricultural Chemistry and Physiology*—Lectures. *Laboratory Practice*—Quantitative Mineral Analysis. Assaying. Organic Analysis. Special Investigations for Graduating Thesis. *Mineralogy*—Identification of Species. *Metallurgy*—Lectures. *Geology*—Dana's Manual. Recitations and Academical Lectures. *Human Anatomy and Physiology*—Academical Lectures. *Mechanics, Steam Engine, and other Prime Motors*—Lectures. *French* (see Select Course).

To advanced students, whether belonging to the regular classes or not, who desire to give attention to particular branches of chemistry, or to pursue original investigations, every facility is accorded.

The private libraries of the professors, containing the chemical journals and the recent foreign literature of chemistry and mineralogy, the large collections of ores, furnace products, &c., belonging to the School, and the extensive private cabinet of the Professor of Mineralogy, are freely used as aids in instruction.

II. Civil Engineering.

[Under the direction of Professor NORTON.]

The special course in Civil Engineering comprises theoretical and practical studies, and exercises in field operations and in drawing. It is designed, in connection with the studies of the first year, to secure, in addition to a thorough mathematical training, the knowledge of practical science essential to success in the profession of Engineering; and includes the careful study of the applications of Mathematics, Mechanics, Physics, Chemistry, &c.,

to Engineering, the use of Surveying and Engineering Instruments, and an extended course of practice in Field operations and in Drawing. The student is also enabled to acquire a sufficient knowledge of French and German to make himself acquainted with professional works published in these languages.

The following is the programme of the course of study:

FRESHMAN YEAR (see page 63).

JUNIOR YEAR.

Mathematics—Descriptive Geometry, with applications. Shades, Shadows, and Linear Perspective. Analytical Geometry of three dimensions. Differential and Integral Calculus. *Astronomy*—Theoretical Astronomy. Practical Problems. *French and German. Practical Surveying*—Triangulation, Survey of a Harbor, &c. Topographical Surveying. *Drawing*—Isometrical, Topographical, Mechanical.

SENIOR YEAR.

Mechanics—Theoretical Mechanics. Applications of Calculus to Mechanics. Mechanics applied to Engineering. Principles of Mechanism. Thermodynamics. Theory of Steam Engine. Prime Movers. *Civil Engineering*—Strength and Stiffness of Materials. Bridge Construction. Stability of Arches. Stone-cutting, with graphical problems. Constitution and properties of Building Materials. Civil Engineering proper, or the Sciences of Construction. *Geology. French*—Selections. *Field Engineering and Surveying*—Location of Roads. Laying out Curves. Geodesy. *Designing*—Designing of Bridges and other Structures. *Drawing*—Architectural and Structural.

The Department is furnished with a full set of instruments for Surveying and Field Engineering, and with a large collection of illustrative models.

HIGHER COURSE OF ENGINEERING.—The student in this department who, on the completion of the three years' course, has taken the degree of Bachelor of Philosophy, has the opportunity of pursuing a higher course, designed to give a special training, preparatory to professional practice. This includes, together with higher theoretical studies, Practical Astronomy, with exercises in astronomical observations with the Transit Instrument, Meridian Circle, Zenith Telescope and Sextant; and a course of exercises in the designing of structures. At the completion of this higher course the degree of Civil Engineer is conferred upon examination, and upon sufficient evidence being given of the ability of the student to design important structures, and make the requisite drawings, calculations and estimates.

III. Mechanical Engineering.

[Under the direction of Professor LYMAN.]

This section is closely connected with that of Civil Engineering, and many of the studies embraced in it are common to both. Prominence is necessarily given to the Mathematics and their applications, and to Mechanical Drawing, as lying, the one, at the foundation of all thorough theoretical training, the other, at that of professional practice. With these are joined other branches of science and modern languages, in order to secure both mental discipline and a better mastery of the special studies of the course.

The main object of the course is, by training the student in "such branches of learning as are related to the mechanic arts," to qualify him, as a mechanical engineer, for contributing toward the more efficient prosecution of these arts his services in the superintendence, construction, designing, or invention of machinery, in the management of mills or other mechanical works, or in the many other ways that lie within the scope of his profession.

It is not, of course, to be expected that the student will leave the institution with a full practical knowledge of the details of his professional work. The inculcation of the principles is the leading object. And yet, it is intended to bring the theory into as close relations with practice, as circumstances and the time allotted to the course will allow. To this end, practice in the use of tools is secured, for students needing it, in first-class machine shops in the city, to such extent as may be required.

PROGRAMME OF STUDIES.

FRESHMAN YEAR (see page 63).

JUNIOR YEAR.

French and German (see Select Course). Descriptive Geometry with Applications. Analytical Geometry of Three Dimensions. Elementary Mechanics. Principles of Mechanism. Differential and Integral Calculus. Metallurgy. Shades, Shadows, and Linear Perspective. Isometrical Projection. Elements of Mechanical Drawing and Principles of Construction. Shading and Tinting, and drawing from patterns.

SENIOR YEAR.

French and German (see Select Course). *Analytical Mechanics*—Strength of Materials. Thermo-dynamics. Theory and Construction of the Steam Engine. Prime Movers. Theory of Machines. Mill work. Examination of Machinery. Mechanical Construction. *Machine-shop* Practice. Architectural Drawing. *Drawing from actual Machines. Designs* of Machines.

IV. Mining and Metallurgy.

[Under the direction of Professors NORTON and BRUSH.]

The Governing Board have determined, henceforth to make this section of the school a post-graduate course analogous to the higher course in Engineering. This change is made to secure more thorough training in Engineering and practical Chemistry, preliminary to the study of Mining, Engineering and Metallurgy. The course will be open to graduates in the sections of Civil Engineering and of Chemistry and Mineralogy. The students will have certain general studies in common, although they will form two divisions according as they desire to become mining-engineers or metallurgists.

The lectures on Mining will discuss in detail known facts in regard to Ore Deposits—strata, beds, veins, or lodes, stockworks or other irregular masses; Dislocations—faults, and other irregularities; Methods of search; Boring of different kinds with the various apparatus; Tools used in various kinds of mining and in different countries; Blasting; Sinking of shafts; Driving of Levels and Galleries; Timbering, Masonry and Tubbing for securing underground openings; Exploitation, or the opening out of mines and the working away of veins and strata; Transportation underground; Winding or raising the minerals to the surface, and machinery and apparatus; Pumps and Pumping Engines; Ventilation, its principles and practice, natural and artificial, by furnaces and machines; Lighting—safety lamps; Mechanical Preparation of Ores, etc.

The lectures in Metallurgy will be divided into: (1.) *General Metallurgy*, including the physical and chemical properties of the metals and their ores, and of slags and other furnace products, the different methods used in both the dry and wet way in the extraction of metals; the character and effect of the different kinds of fuel; the materials employed in the construction of furnaces, crucibles, etc.; the details in regard to different forms of furnaces, blast, etc. Under (2) *Special Metallurgy*, each metal will be considered by itself, its physical and chemical characters given in detail, with the characteristics of its ores, the methods for their assay, and the metallurgical processes employed for the extraction of the metal or metallic compound.

On the completion of a year's study, the student may engage *in the practice* of his profession in connection with mines or metal-

lurgical works, and after one year's practical experience, may on presenting evidence of proficiency, receive a diploma as Mining Engineer or Metallurgist.

V. Course in Agriculture.

[Under the direction of Professors BREWER and JOHNSON.]

This course is intended to prepare the student for the successful management of a farm, by putting him in possession of a knowledge of the most approved methods of culture at present employed, and by explaining, so far as the state of learning admits, the reasons for these methods.

It is not expected to give a young man that familiarity with the mechanical operations of husbandry or that business capacity which is essential to the good farmer. These can only be acquired by assuming or sharing the care of a farm.

The course is in consequence adapted to those who are already familiar with rural affairs. Those who are practically ignorant of the varied details of farm practice can scarcely learn them thoroughly in an agricultural school, nor can they profit fully by the lessons proper to such an institution.

The main features of the course are, in addition to the mathematical and other studies of the first year, extended instruction by lecture in the Theory and Practice of Agriculture in all its branches; instruction in the French and German languages, in the accessory sciences, Chemistry, Botany, Zoölogy, Geology, Meteorology, and training in free-hand Drawing and experimental Chemistry.

Opportunities are offered for more particular attention to special branches, such as Horticulture, Forestry, &c., or to any of the sciences taught in the course, in their more detailed or specific applications.

In addition to the above brief programme, other topics of special interest and application in agricultural pursuits receive attention.

Excursions under the direction of the professors will teach the methods of out-door observation of natural objects, especially plants and insects useful or injurious to the farmer, as well as furnish illustrations of farming operations.

SHORTER COURSE.—For the accommodation of those who do not wish to pursue the entire course, the lectures are so arranged, that those upon the *subjects of more* immediate practical use, are

delivered during the Fall and Winter terms. These embrac Agricultural Chemistry, Practical Agriculture, Stock Breedin and Agricultural Zoölogy. The lectures in the other department are also accessible to such students. Those who desire can thu attend during seven months of the year such a selection from th studies of the full course as will occupy their time profitably. Fc such admission to these lectures no examination is required, bu testimonials of good character and the ability to profit by th instruction must be presented.

Programme of Studies.

FRESHMAN YEAR (see page 63).

JUNIOR YEAR.

Agricultural Chemistry and Physiology—Structure and Physiology of Plants Water, Atmosphere and Soil in their relations to Vegetable Production; Improvement of the Soil by Chemical and Mechanical means. Domestic Animals: th chemical relations of their Food, Digestion, Respiration, Assimilation and Excretion; Milk, Butter, Cheese, Flesh, and Wool as Agricultural products. Lecture *Experimental and Analytical Chemistry*—Laboratory practice. *Meteorology*-Academical Lectures. *Physical Geography*—Lectures. *Zoölogy*—Lecture *Drawing*—Free-hand practice. *French and German*—continued. *Excursions*-Botanical, Zoölogical, etc.

SENIOR YEAR.

Agriculture—The staple crops of the United States, their varieties, cultivatio management, and preparation for market. The Care, Breeding and Raising Domestic Animals. Lectures and Recitations. *Experimental Chemistry*—Laboratory practice—*Agricultural Zoölogy*—Natural History of Domestic Animal Insects useful and injurious to Vegetation. Lectures. *Human Anatomy a Physiology*—Lectures. *Geology*—Lectures and Recitations. *Rural Econom* both American and Foreign. Lectures. *French and German*—continued. *Excu sions*—Botanical, Zoölogical, etc.

VI. Course in Natural History and Geology.

[Under the direction of Professors Eaton, Verrill and Marsh; Laboratory Zoölogy, Trumbull Gallery.]

Students in this department, who are candidates for a degre are required to complete the regular course of studies during th Freshman year. Students not candidates for a degree may hav special courses arranged for them by the Instructors from th studies of the Junior and Senior years, or additional thereto, a desirable.

Programme of Studies.

FRESHMAN YEAR (see page 63).

JUNIOR YEAR.

FIRST TERM.

Zoölogy or Botany—Daily Laboratory instruction; Zoological and Botanical Excursions. *Chemistry*—Academical Lectures. *French and German*—Selections.

SECOND TERM.

Zoology and Paleontology or Botany—Laboratory Practice, Lectures. *Physical Geography*—Lectures and Recitations. *Chemistry*—Laboratory Practice. *French and German*—continued.

THIRD TERM.

Zoology and Paleontology—Laboratory Practice, Lectures, Excursions (land and marine). *Botany*—Gray's Manual; Excursions. *Mineralogy*—Dana, Lectures and Practical Exercises. *French*—continued. *Drawing*—Free-hand Practice.

SENIOR YEAR.

FIRST TERM.

Zoology and Paleontology or Botany—Laboratory Practice, Lectures, Excursions. *Geology*—Dana's Manual, Excursions. *Meteorology*—Academical Lectures. *French*—Selections.

SECOND TERM.

Zoology and Paleontology or Botany—continued. *Geology*—Dana, Recitations and Lectures. *Anatomy and Physiology*—Academical Lectures. *French*—Selections.

THIRD TERM.

Zoology and Paleontology or Botany—continued, with Excursions. *Photography*—Practical Instruction. *Preparation of Thesis. Examinations* in the studies of the course.

The Zoological and Geological Museum, which is accessible to all students, is already extensive, and amply sufficient to afford materials for the most advanced studies, as well as for the illustration of lectures.

A large number of valuable diagrams have been prepared to illustrate the Zoological Lectures, and the microscopes and other instruments belonging to the Instructors are freely used for the same purpose.

VII. Select Course in Science and Literature.

[Under the direction of the Governing Board.]

The Select Course has been arranged to meet the wants of those young men who desire an education based chiefly on mathematical and physical science, and the modern languages, and who are not

disposed to pursue either of the special courses already enumera ted. The Freshman year is the same as in the other department of the school. In the second and third years the scholars ar trained in a selection from the studies prescribed for the other sec tions, and they also attend the lectures of President WOOLSEY an some of the other instructors of the academical department, an recite in text-books which illustrate these lectures.

As it is designed to make this course a valuable means of prepa ration for advanced scientific studies, it is hoped that especiall the younger students who may avail themselves of its advantage will do so with the intention of going forward to pursue stil higher branches of learning. Students who enter upon the highe studies taught in the school, having that acquaintance with Frenc and German, the mathematics, and the natural sciences, whic may be secured by an attendance upon the Select Course, will pu sue their special professional studies with peculiar advantages.

PROGRAMME OF STUDIES.

FRESHMAN YEAR (see page 63).

JUNIOR YEAR.

MODERN LANGUAGES.—*French and German*—continued. English Compositio and Literature.

MATHEMATICS.—Peck's Mechanics, Norton's Astronomy.

NATURAL SCIENCE.—*Agricultural Chemistry*—Lectures. *Zoology*—Lectur and Excursions. *Botany*—Lectures and Excursions. *Mineralogy*—Lecture *Physical Geography*—Lectures and recitations.

HISTORY.—Recitations.

DRAWING.—Free-hand and Architectural.

SENIOR YEAR.

LANGUAGE.—*French*—continued. Whitney's Language and the Study of La guage. Compositions.

NATURAL SCIENCE.—*Botany and Zoology*—continued. *Geology*—Recitatio and Lectures. *Meteorology*—Lectures. *Human Anatomy and Physiology*—Le tures. *Astronomy*—Lectures.

PHILOSOPHY AND HISTORY.—Lectures and recitations, in *History and Politi Philosophy, International Law, Political Economy, Ethics and Metaphysics.*

Preparation of a graduating thesis.

HIGHER AND PARTIAL COURSES.

Students are received to higher and partial courses by speci arrangement with the professors in the departments in which th are interested. (See pp. 60–61.)

OFFICERS.

Add to the list of Instructors on page 5.

WILBUR O. ATWATER, B. A., Wesl.,	*Chemistry.*
EUGENE S. BRISTOL, PH.B.,	*Chemistry.*

STUDENTS,

DURING THE CURRENT ACADEMIC YEAR, 1868-9.

SENIORS.

William Greene Abbot,	*Norwich.*
William Richardson Belknap,	*Louisville, Ky.*
Thomas Gray Bennett,	*New Haven.*
Roman Augustus Bissell,	*Detroit, Mich.*
Charles Augustus Brinley,	*Hartford.*
Francis Dudley Buck,	*New York City.*
Andrew Dwight Chidsey,	*New Haven.*
Clarence Marcellus Clarke,	*New Haven.*
Frederick Smillie Curtis,	*Stratford.*
Augustus Jay DuBois,	*New Haven.*
Joseph Robinson Folsom,	*New Haven.*
Albert Banks Hill,	*Redding.*
Joseph Courten Hornblower,	*Paterson, N. J.*
Nelson Powell Hulst, B.A.	*Washington, D. C.*
Edward Whiting Johnson,	*Norwich.*
Joseph Goodhue Kendall,	*New York City.*
Charles Byron Koon,	*New Haven.*
Augustus Washington Littleton,	*Peoria, Ill.*
Houston Lowe,	*Dayton, O.*
Henry Hoyt Perry,	*Southport.*
Charles Henrique Pope,	*Louisville, Ky.*
Joseph John Skinner,	*Wallingford.*
Robert Schuyler VanRensselaer,	*Bordentown, N. J.*
Charles Alvah Weed,	*Binghamton, N. Y.*
William Robert White,	*Newark, N. J.*
Horace Franklin Whitman,	*Philadelphia, Pa.*
Willard Wendell Wight,	*Natick, Mass.*
Frederick Everett Willits,	*Glen Cove, L. I.*

JUNIORS.

James Whitin Abbott, B.A.	*New Haven.*
Henry Moore Bailey,	*Rutland, Vt.*
Charles Thruston Ballard,	*Louisville, Ky.*
Townshend Stith Brandegee,	*Berlin.*
Daniel Seymour Brinsmade,	*Trumbull.*
Charles Peter Brooks,	*Blooming Grove, N. Y.*
Ralph Howard Burkett,	*Hartford.*
Thomas Elwood Calvert,	*Newtown, Pa.*
Frederic Hosea Churchill,	*New Britain.*
Dorr Clarke,	*Batavia, N. Y.*
Alfred Ronald Conkling,	*New York City.*
Justus Herbert Grant,	*Auburn, N. Y.*
Charles Sheldon Hastings,	*Hartford.*
William Alfred Hinds,	*Wallingford.*
Edward Van Buren Hoes,	*Ottawa, Ill.*
Samuel Nelson Holmes,	*Boonton, N. J.*
William Rufus Hopson,	*Bridgeport.*
Henry Correll Humphrey,	*Stamford.*
William Mead Lovell,	*Covington, Ky.*
Francis Asbury Lowe,	*Washington, D. C.*
William Dennis Marks,	*St. Louis, Mo.*
Arthur Woods Rice,	*West Meriden.*
Evelyn Pierpont Roberts,	*New Haven.*
George Douglass Roseberry,	*Pottsville, Pa.*
Alfred Stanton,	*Sligo, Md.*
George Frederick Stone,	*Hartford.*
Henry Herbert Swinburne,	*Newport, R. I.*
Clarence Augustus Warren,	*Louisville, Ky.*
John George Watson,	*Ayr, Ontario.*
Richard William Woodward, B.A.	*Franklin.*

FRESHMEN.

Horace Andrews,	*New York City.*
Henry Wilcox Ayres,	*Hartford.*
Edwin Faxon Bacon,	*Norwalk.*
Luther White Burt,	*Hartford.*
James Clark Bush,	*New Haven.*
Cornelius Wallis Bussing,	*Brooklyn, N. Y.*
Horace Morison Carleton,	*New York City.*
George Benjamin Chittenden,	*East River.*

urt Cook,	*Huntington, Mass.*
Crane,	*New Haven.*
rt,	*Buffalo, N. Y.*
ıton Dart,	*New London.*
heeler Davenport,	*New York City.*
Franklin Davis,	*Rockville, Pa.*
kerson,	*New York City.*
Stoever Dickson,	*West Chester, Pa.*
ecil Durand,	*Milford.*
ıscall Dwinelle,	*Oakland, Cal.*
ldison Ferry,	*New Haven.*
isha Gorham,	*New Haven.*
enry Green,	*Cincinnati, O.*
arkinson Greene,	*Norwich.*
oodford Griswold,	*New Britain.*
l Griswold,	*Troy, N. Y.*
ıcis Günster,	*Scranton, Pa.*
liam Hall,	*Stamford.*
en Hawkins,	*Wakefield, R. I.*
nt Johnston,	*Davenport, Iowa.*
ols Judson,	*New Haven.*
.eculloch Keasbey,	*Newark, N. J.*
ederick Klein,	*New Haven.*
anville Lobdell,	*Wilmington, Del.*
vard McCall,	*New York City.*
estley McClean,	*Springfield, Mass.*
sius Maher,	*New Haven.*
illiam Mather,	*New Haven.*
ırkey Mead,	*Dayton, Ohio.*
Merriman,	*Plantsville.*
is Moore,	*Fond du Lac, Wisc.*
vis Morton,	*New York City.*
art Pierpont,	*North Haven.*
Eugene Powell,	*Chester Springs, Pa.*
klin Quigley,	*Wilmington, Del.*
ırd Ranger,	*Norwich.*
Lockwood Sanford,	*New Haven.*
dford Sargent,	*New Haven.*
e Stickney,	*Rockville.*
inton Terry,	*Terryville.*
en Ziegler,	*Philadelphia, Pa.*

STUDENTS PURSUING ADVANCED AND SPECIAL COURSES.

Joseph Sampson Adam,	*Canaan.*
Wilbur Olin Atwater, M.A. Wesleyan University,	*Brandon, Vt.*
Leonard Strong Austin, PH.B.	*Hartford.*
Eugene Stuart Bristol, PH.B.	*New Haven.*
Henry Gaylord Buckingham,	*Stamford.*
Sherman Hartwell Chapman, B.A.	*Bridgeport.*
William Richard Cutter,	*Woburn, Mass.*
Rev. John Dickinson,	*Westville.*
Wilbur Wells Flagg,	*Yonkers, N. Y.*
William H. Fulton,	*New Haven.*
Oscar Harger, B.A.	*Oxford.*
William Sturges Harris,	*Binghamton. N. Y.*
Frederick Gold Lyman,	*Goshen.*
Joseph L. McDaniel,	*Wilmington, Del.*
Charles Clarence Maxson,	*Westerly, R. I.*
William Augustus Miles,	*Salisbury.*
William Gilbert Mixter, PH.B.	*New Haven.*
Charles Kinney Needham, PH.B.	*Louisville, Ky.*
Edward Thomson Nelson, B.A. Ohio Wesleyan Univ.,	*New Haven.*
George Henry Perkins, B.A.	*New Haven.*
William Augustus Rogers, M.A. Brown, Prof. in Alfred Univ.	*Alfred Centre, N. Y.*
Henry Augustus Rowland,	*Newark, N. J.*
Peter Shoenberger,	*Cincinnati, O.*
Sidney Irving Smith, PH.B.	*New Haven.*
Edgar Verrill,	*Norway, Me.*
Harwood Wakeman,	*New York City.*
Shippen Wallace,	*Philadelphia, Pa.*
Harrison Edwin Webster, B.A. Union College, N. Y.	*Schenectady, N. Y.*
Samuel Wheeler, B.A.	*Bridgeport.*
Henry Shaler Williams, PH.B.	*New Haven.*

SUMMARY—Seniors, ...28
Juniors, ...30
Freshmen, ...49
Special Students, ...30

Total, 187

ANNUAL REPORT

OF THE

STATE BOARD OF VISITORS

OF THE

HEFFIELD SCIENTIFIC SCHOOL

OF

YALE COLLEGE:

WITH ACCOMPANYING STATEMENTS.

1869–70.

Printed by order of the General Assembly.

NEW HAVEN:
PRINTED BY TUTTLE, MOREHOUSE & TAYLOR.
.....
1870.

Historical Note.

The Department of Philosophy and the Arts, to which the Scientific School pertains, was instituted in Yale College at the commencement of 1846. In 1860, Sheffield Hall, the gift of Mr. JOSEPH E. SHEFFIELD, of New Haven, was presented to the School, and immediately occupied. He then gave a fund of Fifty Thousand Dollars as the partial endowment of three professorships. In 1866, the Hall was enlarged and refitted a second time, at the expense of the original benefactor.

The Congressional appropriation, made in 1862, for the establishment of a Scientific College, was directed to this institution by the General Assembly of 1864.

In 1866, Mr. George Peabody, of London, gave a fund of $150,000, to found, in connection with Yale College, a Museum of Natural History.

The General Instruction fund is made up of the contributions of a large number of benefactors,—the names of a part of whom are given in the Fourth Annual Report, while the names of others will be given next year.

Special Articles contained in the previous Annual Reports.

1. 1866. Historical Statement.
2. 1867. Description of Sheffield Hall.
3. 1868. Aim and Object of Scientific Education.
4. 1869. Preliminary Roll of Benefactors, Officers and Students, 1846–69.

Corporation of Yale College.

May, 1870.

PRESIDENT,

REV. THEODORE D. WOOLSEY, D.D., LL.D.

FELLOWS.

HIS EXC. JAMES E. ENGLISH,	HIS HONOR JULIUS HOTCHKISS.
REV. JOSEPH ELDRIDGE, D.D.,	REV. GEORGE J. TILLOTSON,
REV. EDWIN R. GILBERT,	REV. DAVID S. BRAINERD,
REV. ELISHA C. JONES,	REV. LEONARD BACON, D.D,
REV. HIRAM P. ARMS, D.D.,	REV. MYRON N. MORRIS,
REV. SAMUEL G. WILLARD,	REV. GEORGE RICHARDS,
HON. ELISHA JOHNSON,	HON. JOSEPH D. BARROWS,
HON. ELIAB A. CONVERSE,	HON. EDWARD HARLAND,
HON. LUCIEN W. SPERRY,	HON. IRA G. BRIGGS.

Councillors of the Sheffield Scientific School.

(*Each appointed for a term of five years.*)

JAMES E. ENGLISH, New Haven.

MARSHALL JEWELL, Hartford.

JOSEPH R. HAWLEY, Hartford.

JOSEPH E. SHEFFIELD, New Haven.

HENRY FARNAM, Chicago.

OLIVER F. WINCHESTER, New Haven.

M. DWIGHT COLLIER, St. Louis.

(*Three vacancies to be filled.*)

State Board of Visitors:

CONSTITUTING, WITH THE SECRETARY OF THE SCHOOL, THE BOARD FOR THE APPOINTMENT OF STATE STUDENTS.

May 1869 to May 1870.

GOVERNOR,

His Exc. MARSHALL JEWELL, Hartford.

LIEUTENANT GOVERNOR,

His Honor FRANCIS WAYLAND, New Haven.

STATE SENATORS,

Hon. GEORGE M. LANDERS, New Britain.
Hon. ERASMUS D. AVERY, Groton.
Hon. JAMES S. TAYLOR, Danbury.

SECRETARY OF THE STATE BOARD OF EDUCATION,

Rev. BIRDSEY G. NORTHROP, New Haven.

May 1870 to May 1871.

GOVERNOR,

His Exc. JAMES E. ENGLISH, New Haven.

LIEUTENANT GOVERNOR,

His Honor JULIUS HOTCHKISS, Middletown.

STATE SENATORS,

Hon. ELISHA JOHNSON, Hartford.
Hon. LUCIEN W. SPERRY, New Haven.
Hon. ELIAB A. CONVERSE, Stafford.

SECRETARY OF THE STATE BOARD OF EDUCATION,

Rev. BIRDSEY G. NORTHROP, New Haven.

SECRETARY OF THE SHEFFIELD SCIENTIFIC SCHOOL,

Prof. DANIEL C. GILMAN, New Haven.

Instructors.

WILLIAM A. NORTON,
Civil Engineering and Mathematics.

WILLIAM D. WHITNEY,
Linguistics and German.

DANIEL C. GILMAN,
Physical Geography.

WILLIAM H. BREWER,
Agriculture.

OTHNIEL C. MARSH,
Palæontology.

MARK BAILEY,
Elocution.

JOSIAH W. GIBBS,
French.

DANIEL H. WELLS,
Mathematics.

WILLIAM G. MIXTER,
Chemistry.

CHESTER S. LYMAN,
Industrial Mechanics and Physics.

GEORGE J. BRUSH,
Metallurgy and Mineralogy.

SAMUEL W. JOHNSON,
Agricul. and Analytical Chemistry.

DANIEL C. EATON,
Botany.

ADDISON E. VERRILL,
Zoölogy and Geology.

LOUIS BAIL,
Drawing.

THOMAS R. LOUNSBURY,
English.

SIDNEY I. SMITH,
Zoölogy.

HENRY S. WILLIAMS,
Palæontology.

Nominated as Professor, (subject to the appointment of the Corporation of Yale College.)

WILLIAM P. TROWBRIDGE, M.A., late Capt. U. S. Engineer Corps,
Mechanical Engineering.

By invitation of the Governing Board,

Prof. ALFRED P. ROCKWELL, M.A.,
Mining.

By appointment of the U. S. Government,

Brig. Gen. BENJAMIN S ROBERTS, U. S. A.,
Military Science.

SUMMARY.

Graduate Students,		28
Undergraduate Students,		
Seniors,	25	
Juniors,	37	
Freshmen,	39	101
Special Students,		12
TOTAL,		141

STUDENTS.

GRADUATE STUDENTS.

James Whitin Abbott, A.B.	*New Haven.*
William Richardson Belknap, PH.B.	*Louisville, Ky.*
Charles Augustus Brinley, PH.B.	*Hartford.*
Eugene Stuart Bristol, PH.B.	*New Haven.*
Frederick Smillie Curtis, PH.B.	*Stratford.*
Rev. James A. Deane, A.M. Wesleyan University.	*Westville.*
Rev. John Dickinson,	*Westville.*
Augustus Jay DuBois, PH.B.	*New Haven.*
Jonathan Edwards, Jr., A.M., M.D.	*New Haven.*
George Bronson Farnam, M.D.	*New Haven.*
Joseph Robinson Folsom, PH.B.	*New Haven.*
Oscar Harger, A.B.	*Oxford.*
Bernard James Harrington, A.B. McGill University, Montreal.	*Montreal, Canada.*
Albert Banks Hill, PH.B.	*Redding.*
William Henry Hotchkiss, A.B.	*New Haven.*
Nelson Powell Hulst, A.B., PH.B.	*New Haven.*
George Thomas Kennedy, A.B. McGill University, Montreal.	*Montreal, Canada.*
William Gilbert Mixter, PH.B.	*New Haven,*
George Rice, A.M., M.D.	*Framingham, Mass.*
Mitchell Davison Rhame, A.B.	*Atlantic, N. Y.*
Horatio Seymour, B.A.	*Utica, N. Y.*
George Henry Sherman, M.D. Coll. Phys. and Surg., N. Y.	*Westfield, Mass.*
Sidney Irving Smith, PH.B.	*New Haven.*
Harrison Edward Webster, A.B. Union College, N. Y.	*Schenectady, N. Y.*
Eli Whitney, A.B.	*New Haven.*
Joseph Thompson Whittelsey, PH.B.	*New Haven.*
Henry Shaler Williams, PH.B.	*New Haven.*
Richard William Woodward, A.B.	*Franklin.*

GRADUATE STUDENTS, 28.

UNDERGRADUATE STUDENTS.

SENIORS.

Henry Moore Bailey,	*Rutland, Vt.*
Charles Thruston Ballard,	*Louisville, Ky.*
Thomas Gray Bennett,	*New Haven.*
Townshend Stith Brandegee,	*Berlin.*
Daniel Seymour Brinsmade,	*Trumbull.*
Charles Peter Brooks,	*Blooming Grove, N.*
Thomas Elwood Calvert,	*Newtown, Pa.*
Frederic Hosea Churchill,	*New Britain.*
Dorr Clarke,	*Batavia, N. Y.*
Alfred Ronald Conkling,	*New York City.*
Justus Herbert Grant,	*Auburn, N. Y.*
Charles Sheldon Hastings,	*Hartford.*
William Alfred Hinds,	*Wallingford.*
Edward VanBuren Hoes,	*Ottawa, Ill.*
William Rufus Hopson,	*Bridgeport.*
Henry Correll Humphrey,	*Stamford.*
Francis Asbury Lowe,	*Washington, D. C.*
William Dennis Marks,	*St. Louis, Mo.*
Arthur Woods Rice,	*West Meriden.*
Evelyn Pierpont Roberts,	*New Haven.*
George Douglass Roseberry,	*Pottsville, Pa.*
Alfred Stanton,	*Sligo, Md.*
George Frederick Stone,	*Hartford.*
Clarence Augustus Warren,	*Louisville, Ky.*
John George Watson,	*Ayr, Canada.*

SENIORS, 25

JUNIORS.

drews,	*New York City.*
cox Ayres,	*Hartford.*
on Bacon,	*Norwalk.*
ıite Burt,	*Hartford.*
'k Bush,	*New Haven.*
ıjamin Chittenden,	*East River.*
Crane,	*New Haven.*
rt,	*Buffalo, N. Y.*
ton Dart,	*New London.*
ıeeler Davenport,	*New York City.*
:erson,	*New York City.*
;toever Dickson,	*West Chester, Pa.*
:cil Durand,	*Milford.*
scall Dwinelle,	*Oakland, Cal.*
dison Ferry,	*New Haven.*
lgway Gawthrop,	*Unionville.*
sha Gorham,	*New Haven.*
nry Green,	*Cincinnati, O.*
ɔodford Griswold,	*New Britain.*
:n Hawkins,	*Wakefield, R. I.*
ɔls Judson,	*New Haven.*
cculloch Keasby,	*Newark, N. J.*
derick Klein,	*New Haven.*
ınville Lobdell,	*Wilmington, Del.*
illiam Mather,	*New Haven.*
lerriman,	*Plantsville.*
is Moore,	*Fond du Lac, Wisc.*
ris Morton,	*New York City.*
ıart Pierpont,	*North Haven.*
Eugene Powell,	*New Haven.*
tlin Quigley,	*Wilmington, Del.*
rd Ranger,	*Norwich.*
ɔockwood Sanford,	*New Haven.*
lford Sargent,	*New Haven.*
acy Scovill,	*Cleveland, O.*
ınton Terry,	*Terryville.*
:n Ziegler,	*Philadelphia, Pa.*

JUNIORS, 37.

FRESHMEN.

Jacob Jackson Abbott,	*Yarmouth, Me.*
James Peter Bogart,	*New Haven.*
Burwell Henry Boykin,	*Camden, S. C.*
William Bristol,	*New Haven.*
Harry Hill Buck,	*Orland, Me.*
Edwin Samuel Burnham,	*Wallingford.*
James Richard Burroughs,	*Bridgeport.*
Robert Colgate,	*Riverdale, N. Y.*
Byron Hood Culbertson,	*Pittsburgh, Pa.*
William Darlington Evans,	*West Chester, Pa.*
Robert Evans Fisher,	*Milford.*
Wallace Leland Folsom,	*New Haven.*
William Saunders Green,	*Cincinnati, O.*
James John Guthrie,	*Mumford, N. Y.*
Daniel Webster Hering,	*Johnsville, Md.*
Harry Hamilton Honoré,	*Chicago, Ill.*
William Thompson Jenkins,	*Falmouth, Mass.*
Charles Louis Johnson,	*Ansonia.*
Samuel Trevor Knapp,	*New York City.*
Harrison Wheeler Lindsley,	*New Haven.*
John Chester Lyman,	*Northampton, Mass.*
Frank Oscar Maxon,	*Norwich.*
Robert Douglass Millholland Maxwell,	*Wilmington, Del.*
George Noyes Miller,	*Wallingford.*
Charles Theodore Morse,	*New Haven.*
Thomas Perkins Nevins,	*Waterford.*
James Yeatman Player,	*Nashville, Tenn.*
Theophil Mitchell Prudden,	*New Haven.*
Willard Berthrong Roberts,	*Hartford.*
Thomas Hubbard Russell,	*New Haven.*
William Edward Smith,	*Goshen.*
Frank Hale Stickney,	*Rockville.*
Aretas Whittelsey Thomas,	*Bethlehem.*
Charles Austin Tibbals,	*Brooklyn, N. Y.*
Edward Andrews Tuttle,	*West Haven.*
George Judson Walker,	*Buffalo, N. Y.*
Daniel Wardwell,	*Rome, N. Y.*
Frederic Floyd Weld,	*Guilford.*
William Brenton Welling,	*New York City.*

FRESHMEN, 39.

SPECIAL STUDENTS NOT CANDIDATES FOR A DEGREE.

ı Sampson Adams,	*Canaan.*
ı Daniel Anway,	*Wantage, N. J.*
ŗ Lamertine Dowd,	*Seville, O.*
d Augustus Ellsworth,	*La Fayette, Ind.*
Harpen Fulton,	*New Haven.*
Wool Griswold,	*Troy, N. Y.*
Lockwood,	*South Norwalk.*
ɜ Chestley McClean,	*Springfield, Mass.*
Crittenden Russell,	*Frankfort, Ky.*
s Pierson Spining,	*Glendale, O.*
Freeland Verrill,	*Portland, Me.*
n Wallace,	*Philadelphia, Pa.*

SPECIAL STUDENTS, 12.

ENTRANCE PRIZE.

rize of $20, offered for the best examination passed by a member of the ın Class, entering in 1869, was divided between JACOB JACKSON ABBOTT, ıouth, Me., and DANIEL WARDWELL, of Rome, N. Y., who were adjudged merit.

A like prize of $20 is offered for the best examination passed in entering hman Class in 1870.

REPORT OF THE STATE BOARD OF VISITORS.

To the General Assembly of the State of Connecticut:

THE undersigned, in behalf of the State Board of Visitors of the Sheffield Scientific School, respectfully report that they have not only performed the duties required by law in the selection of State Students, but by repeated visits to the institution and by frequent conferences with the instructors they have become well acquainted with the management, the courses of instruction, and the aims of this college of pure and applied science.

The number of pupils during the past year has been one hundred and forty-one, of whom seventy-one were from the State of Connecticut, and the remainder from twenty-one other States. All the state scholarships have been taken up, but fortunately no one has been rejected because of inability to pay for his tuition. Engineering in its various branches, Chemistry in its manifold applications, Natural History in all its departments, Agriculture and the Mechanic Arts, with the Modern Languages, still constitute the prominent subjects of study. The collections of the school are rapidly increasing. Among the most noteworthy accessions of the year are the various models and pieces of apparatus purchased last summer in Europe by Professor C. S. *Lyman, from the* fund contributed by Mr. M. Dwight

Collier of St. Louis, and other gentlemen. Still further purchases are to be made from this fund. Quite recently, a library of mathematical books, collected by William Hillhouse, M. D., of New Haven, and including many works on the applications of Mathematics to the Mechanic Arts, has been purchased and given to the school by Mr. Joseph E. Sheffield of New Haven. The sum of Five hundred dollars has also been given by Mr. William Johnson of New Haven for the purchase of maps, reliefs and other means of illustrating geographical studies; and a department of the United States Government has bestowed on the school a valuable collection of hydrographical charts published by the British Admiralty from the surveys of various European governments.

Notwithstanding these and many other liberal gifts for specific objects, it has been and still is a matter of grave solicitude as to whether the instruction fund of the school can be made adequate to the maintenance of so large a corps of teachers, as is absolutely essential to the life of a scientific school so varied in its usefulness and so comprehensive in its scope as the institution at New Haven. The demand for experienced teachers of science in this country is such that constant efforts are made to induce the Sheffield professors to accept more lucrative positions elsewhere; but these overtures have thus far been declined because the persons receiving them are deeply interested in their present work, and are confident that when their aims and objects are understood by the public, sufficient means will be contributed to place the institution on an enduring and sufficient basis.

Impressed by these facts, several of the present and former *members* of this Board, together with a few other gentlemen,

assembled at the school December 7, 1869, and after listening to the statements of the professors, inaugurated a movement which is still in progress for the more complete endowment of the various professorships and for the general purposes of the establishment. It is deemed premature to announce as yet the names of those liberal gentlemen in Connecticut and New York who have already made their subscriptions to this proposed endowment; especially as it is known that there are other persons who are intending at an early day to give their aid to the movement. A full report on this subject is therefore deferred. In the mean time, the undersigned would commend to the consideration of wealthy and liberal gentlemen, a statement published in December last on the character and work of the school, which is signed by nearly all the persons still living who have held the office of Governor or Lieutenant Governor in the State of Connecticut.

The attention of the General Assembly is also respectfully invited to the statements of the Governing Board and Faculty of the School which will be as usual printed in connection with this report as a portion thereof.

At the present time, when almost every civilized country is increasing its institutions for education in science, and when every state in this Union is considering the importance of securing good technical schools, Connecticut cannot afford to lose the advantages she has gained. This industrious commonwealth will rival any portion of the world in the variety of its manufactured goods, requiring for their production scientific skill and often cultivated taste. Before the artisans can be trained as in European countries for their special pursuits, a large number of skilled *teachers must be educated*, to act as leading men,—owners,

engineers, superintendents, foremen, and instructors,—in all manufacturing villages and towns of the State. Such a bod trained men will soon be provided by the Scientific Schoo New Haven. But this is not the exclusive work of the in tution. Science is to be advanced for its own sake and for sake of its applications to the wants of society; and the ac mulated experience and knowledge of the world are to be pla at the command of every intelligent enquirer. The Sheff instructors by their investigations, their lectures, their boo their correspondence and their personal counsels are helping the interests of the State in many ways which cannot be e merated; and they are endeavoring to show that the study the laws which the Creator has established for the governm of the world is at once ennobling to the mind and product of material advantage to the human race.

MARSHALL JEWELL,
Chairman of the State Board of Visitors

BIRDSEY G. NORTHROP,
Secretary of the State Board of Education.

NEW HAVEN, June 3, 1870.

ANNUAL STATEMENT

OF THE GOVERNING BOARD.

presenting their fifth annual statement in respect to the pro-
of the SHEFFIELD SCIENTIFIC SCHOOL of Yale College, the
rning Board refer with pleasure to the manifold marks of
c confidence with which their recent work has been attended.
ong desire to make the education here afforded as good as
in any department of Yale College, a recognition of the im-
nce of having a large company of teachers who are trained
ecialists in the various branches to which they are devoted,
, disposition to provide various courses of instruction for dif-
t classes of students,—these and other considerations have
ıe Board, from time to time, to propose additional members
e instruction-corps, and thus to increase the efficiency of the
ution, at the expense of their own salaries. Accordingly
'ear the Corporation of Yale College, at the request of the
d, reduced the salaries of professors giving their full time to
ıchool, from twenty-three hundred dollars to two thousand
rs, hoping thus to keep the outlays within the income. It
well understood, however, that a vigorous effort should be
: to increase the endowment of the institution, and it was
ght that the effort could not fail to be successful.

the invitation of this Board, several of the past and present
bers of the State Board of Visitors, and a few other gentle-
including Governor Jewell, Governor English, Governor
ley, Lieutenant Governors Winchester, Douglas, Averill and
e, and Secretary B. G. Northrop, came together in the Libra-
ı Tuesday evening, Dec. 7, 1869, for the purpose of a familiar
:rence in relation to the school. Governor Jewell presided, a
ment of affairs was presented by the instructors, and various
rks were made by the gentlemen who were present, with spe-
:eference to the best method of securing an endowment. In
rdance with *the request of that* meeting, Gov. Hawley drew

up a full and careful exposition of the character, aim, and needs of the school, which soon received the endorsement of nearly all the persons still living who have held the office of Governor or Lieutenant Governor in Connecticut,—and was published in the various papers of the State.

On the following day, Dec. 8, 1869, the Corporation of Yale College assembled in the same place, and adopted a minute commending the proposed endowment-movement to the confidence of the friends of scientific education. They also received with favor a proposal to designate from among the friends of the school, several gentlemen of well known character and influence, who should act as a special body of Councillors, aiding the instructors in their plans of enlarged usefulness. It was decided that this honorary Board should consist of ten members, each holding office five years, and that seven of the members should be designated at once, leaving three vacancies to be filled hereafter. The following gentlemen were then invited to act in this capacity: His Excellency M. Jewell, Governor of the State, Ex-Governor James E. English, Maj. Gen. Jos. R. Hawley, Hon. O. F. Winchester, Joseph E. Sheffield, Esq., Henry Farnam, Esq., and M. Dwight Collier, Esq. All of these gentlemen but one, who is out of the country, have signified their willingness to serve the school, and during the last few months have with hearty coöperation responded to the frequent calls which have been made upon them for counsel and assistance.

These two meetings may be regarded as marking an important crisis in the history of the school. Attractive invitations had then been recently extended to some of the professors to accept honorable and remunerative posts in other institutions, and they as well as their associates were desirous of ascertaining whether or not this department of Yale College was likely to receive the financial assistance of which it stood in need. A subscription was commenced at once, in the hope of raising a quarter of a million dollars. Thus far it has made slow progress,—only seventy thousand dollars having hitherto been received. But the Governing Board are well aware how many prejudices are to be overcome among the practical business men, who look with distrust upon any phase of college training, and among the college-bred men who look with suspicion if not with hostility upon what they call the New Education; and between the two, *they* are aware that time, with good results, will be the best

mediator. They also believe that the aim and object of scientific education, as here provided, will at length receive as hearty approval from the public as has already been bestowed upon it, by the President and Fellows of Yale College and by the former Chief Magistrates of the State. They desire therefore to encourage the closest scrutiny of the work of the school, confident that it is fitted to supply some of the most pressing wants of modern society.

In view of the fact that many persons have signified their intention to aid this subscription, who are not yet ready to say in what amount, it is deemed inexpedient at this time to publish the names of any of the subscribers; but in due time the full record will be given. Meanwhile and always the thanks of the instructors are heartily extended to the various gentlemen in Connecticut and New York who have so generously bestowed their aid. If there are others who are willing to coöperate in this work, copies of our appeal and of our forms of subscription will be furnished at any time. There are many other generous gifts received within the year, (aside from this endowment subscription,) which we gratefully acknowledge.

At the last Commencement dinner of Yale College, His Excellency Governor Jewell being called upon for a speech, responded with his usual cordiality, and in the course of his remarks expressed a desire to show his interest in the Scientific School by contributing five hundred dollars to its funds. This amount he promptly paid.

A few weeks later, Mr. William Johnson of New Haven, having been led by one of his business acquaintance to visit the institution, made a generous gift of five hundred dollars to be expended by one of the professors in purchasing maps, charts, reliefs, and other means of illustrating geographical studies.

Mr. Joseph A. Rogers, a graduate of the school, lately attached to the National Observatory in Washington, and now an officer of the Hydrographical office, secured from the proper authorities and forwarded to us a collection of five hundred and sixty-three charts, published by the British Admiralty from the surveys of different governments in all quarters of the globe.

From the Hon. Hamilton Fish, U. S. Secretary of State, the school has received, through Professor W. P. Blake, some important geological works on the Gold Fields and Mineral Deposits of Victoria, forwarded to the U. S. Government by the Trustees

of the Melbourne Public Library. The following letter, which explains the character of the work, accompanied the transmission. A collection of the scientific works recently published by New Haven gentlemen, is to be sent in acknowledgment.

DEPARTMENT OF STATE,
Washington, June 23, 1870.

SIR,—This Department has received through the United States Consul at Melbourne, Australia, six copies of each of the following named works:—The Goldfields and Mineral Deposits of Victoria, Notes and Observations upon the Nuggetty Reef, Maps of Victoria, geologically colored, Maps of the Geological Survey of Victoria, (as far as issued), forwarded by the Trustees of the Melbourne Public Library, with the request that they may be presented on behalf of the Trustees, as donations to some of the principal libraries of the United States.

The object is that the publications shall reach some of the States which by their men of science have contributed largely to the knowledge of the geology of this country, and without making an exchange a condition of the extended courtesy, it is evident that the leading motive of the offer is the reception in return of similar publications for the Melbourne Library.

With a desire to promote the objects of the Trustees, I have directed a set of these publications to be sent to the Library of the Sheffield Scientific School.

I am requested to state that "it will be esteemed a very considerable favor if the Trustees be allowed the privilege of placing on the shelves of the Library works of a similar character published by authority of the State."

Your acknowledgment, and any books you may desire to transmit, may be forwarded to this Department.

I am, sir, very respectfully, your obedient servant,

HAMILTON FISH.

Toward the close of the year the Library received a very important addition. Mr. Joseph E. Sheffield, to whom in so many ways we are indebted, purchased and presented a remarkable collection of mathematical treatises, collected during the last twenty-five years by Dr. Wm. Hillhouse of New Haven. This library is well known to the mathematicians of the country. It is especially full in the best editions of the best writers in pure mathematics, but it also contains a large number of volumes which pertain to the mathematical aspects of Mechanics, Horology, Physics, Astronomy, etc. Dr. Hillhouse added many books not strictly mathematical to the collection, as it passed from his hands to ours, and after the transfer was complete, generously gave five hundred dollars to be expended in binding the books or in any other way more serviceable to the school. He has also given us a bust, in plaster, of Dr. Nathaniel Bowditch.

We have also received the gratifying information from the Novelty Iron Works of New York city, that the mechanical drawings

accumulated there during the last twenty-five years, and illustrating a great variety of constructions, are presented to this institution. As they are not yet received, we defer to the next report a more particular statement in respect to this most welcome gift.

A gentleman of New Haven, who has twice before made a liberal contribution to our resources, Wells Southworth, Esq., learning that if it could be obtained, a set of the English patent office reports would be of great service, volunteered to give one thousand dollars toward the expense of binding this very extended series, and inquiries are already in progress as to the possibility of securing the work.

From Mr. Eli Whitney, son of the inventor of the cotton-gin, (a graduate of Yale College in 1792,) the school has received, at the solicitation of the instructors, one of the original gins made by the inventor. It is not only interesting as a historical memento, but because it shows how this invention, which has exerted such a marvellous influence upon modern society, came into use perfected by the original contriver.

Mr. Eli Whitney Blake of New Haven, has likewise presented a working model of the stone crushing machine of his invention,—a contrivance extensively used in the construction of roads, the dressing of ores, and for other purposes at home and abroad.

There is another gratifying acknowledgment to be made. Three of the graduates who had held State Scholarships while students, have presented to the school sums of money corresponding with the tuition which under ordinary circumstances they would have paid. Our funds have been thus augmented by the gift of Mr. J. J. Skinner, $375, Mr. W. G. Abbot, $300, and Mr. F. J. Leavens, $100.

Another welcome contribution has been received from Messrs. Perkins & Chatfield. On completing some changes in the mason work of Sheffield Hall, they sent to the school a receipted bill for their work, amounting to $83.82; and in addition they proposed to pay for the annual subscription to the "London Builder," a series of which, well bound, from the beginning, they had previously presented.

It should be mentioned, also, that the school has the use of a considerable amount of valuable apparatus recently deposited by Prof. G. F. Barker, including an air pump, electric clock, and various pieces of *electrical, magnetic* and galvanic apparatus.

In connection with these acknowledgements, the authorities of the school desire to make grateful mention of a gift, not indeed bestowed upon the school, but immediately connected with it, in a part of its provisions. Mr. Samuel Holmes, of the Scoville Manufacturing Company in Waterbury and New York, has given the sum of one thousand dollars, the income of which is to be bestowed on a student from Waterbury or one of the adjacent towns, while pursuing his studies in the Sheffield School. The privilege of selecting the scholar rests with the Board of Agents of the Bronson Library Fund. The following is the letter of Mr. Holmes, referring also to four similar foundations for the benefit of classical students.

NEW YORK, October 7, 1869.

To the Board of Agents of the Bronson Library Fund, Waterbury, Conn.

Gentlemen:—For the interest which I have in my native town and with the hope of encouraging a desire for liberal education among the youth of Waterbury and vicinity, I have arranged in connection with other payments to Yale College, for the payment of Five Thousand Dollars to be applied as named herewith, viz:

"That said five thousand dollars shall when paid, constitute five scholarships of one thousand dollars each, one of them being in the Scientific School, and one in each of the four classes in the Academical department, the income arising from which shall be annually paid to such students from the towns of Waterbury, Wolcott, Prospect and Middlebury in the State of Connecticut as shall be appointed by the Board of Agents of the Bronson Library Fund, preference being first given to those students who have received the principal part of their education in the public schools of Waterbury and afterward to students from the towns in the above mentioned order: such appointment to be made by said board within sixty days after notification by some officer of said college, and in default of said appointment by said board after such notification then the income of that year of any scholarships so vacant to be appointed by the Prudential committee of said college, or their successors, to such deserving students needing aid as they may select, preference being given to those having the ministry in view, it being in the power of the President of the college to withhold the appropriation made in any year from any scholar appointed on any of these foundations for immoral conduct or a violation of the laws of the college."

With the further condition that proper public notice shall be given by your board as well as by your successors, of any vacancies to be filled,

I am, gentlemen, Yours very truly,

SAMUEL HOLMES

PROF. LYMAN'S PURCHASES OF APPARATUS.

In the summer of 1869, Prof. Lyman visited Europe for the purchase of models and apparatus in the departments of Mechanics and Physics.

The funds for this purpose, as was mentioned in the Report of last year, were contributed by a number of individuals; the first and largest gift being that of M. Dwight Collier, Esq., of St Louis, to the amount of $5000, for forming a Cabinet of Mechanical Models and Apparatus, as a memorial of his brother, Thomas F. Collier, who for two years previous to his death in 1868, had been a member of the school. Mr. Collier afterwards gave $1000 more to pay the expenses incidental to making purchases abroad. To this fund were added, on the eve of Prof. Lyman's departure, other contributions for the purchase more particularly of physical apparatus, as follows:—Joseph E. Sheffield $2700 (10,000 francs), Henry Farnam $1000, E. E. Salisbury $200, John A. Blake $100, Eli W. Blake $50, Alfred Walker & Co. $25. It should be added, in this connection, that Messrs. W. T. Hatch & Son, of New York, made no charge for commissions, or services, on the funds that passed through their hands, and that, with like liberality, Messrs. J. W. Tucker & Co., of Paris, remitted the amount of their commissions. A similar abatement, to a less amount, was made by Messrs. Williams & Guion, of New York, in connection with steamer charges.

Prof. Lyman has made the following report:

To the Governing Board:

Leaving New York, by the Steamship Colorado of the Williams & Guion line, on the 19th of April, I again reached that city, by the Steamer Nevada of the same line, on the 13th of September, having sailed with the same excellent commander (Capt. Green) on both voyages.

Prof. H. A. Newton was my constant traveling companion, and to his highly valued counsel and assistance I was very greatly indebted for the successful accomplishment of the objects of the trip. In various European cities, we visited the principal makers of apparatus and models, and also the leading institutions of science, with their extensive physical and mechanical cabinets. At every point we received the utmost courtesy and assistance from the many men of science whom it was our good fortune to meet. To distinguish any of these might seem almost invidious, when all were so attentive and obliging. Yet it seems no more than proper that the names of some to whom we happened to be placed under particular obligations, should be mentioned in this connection, by

way of partial acknowledgment of their many friendly offices. Among such we have the pleasure of reckoning the well known names of Professors Salmon and Haughton of Dublin, Roscoe of Manchester, Rankine of Glasgow, Tait of Edinburgh, Tyndall, Miller, Huggins, Lockyer and Stewart of London, Clifton of Oxford, and Willis of Cambridge; and on the Continent, Messrs. Jamin, D'Abbadie, Chasles, Tresca, Daubree, and Charles St. Clair Deville of Paris, Argelander and Clausius of Bonn, Magnus and Dove of Berlin, Weisbach of Freiberg, Geinitz of Dresden, Littrow of Vienna, Liebig, Beetz, and Ludewig of Munich, and more especially Zeuner of the Zurich Polytechnicum, through whose kind offices arrangements were made for obtaining copies of a portion of his very extensive and valuable collection of models in mechanics. These copies were made by a mechanician of Zurich, Meier-Freytag, under the supervision of Prof. Zeuner, whose efficient and kindly aid has placed not only myself but our institution under lasting obligations to him.

The Polytechnicum, in which he is one of the most distinguished professors, stands at the head of the Scientific Schools of Europe, and is at the present time exerting a marked influence on the various industries not only of Switzerland, but of Southern Germany, and, indeed, of all Europe; for its pupils are of nearly all the European nationalities, and more than half of the 700 come from outside of Switzerland. This institution may be regarded as in most respects a model for institutions of the kind, and as such it has been visited by persons from other countries interested in scientific education, for the purpose of studying its organization and the secret of its great success; for its entire growth has occurred chiefly within the last ten years. It is only one, however, of a great number of similar institutions in various parts of Europe; as at Carlsruhe, Munich, Vienna, Berlin, and many other places. These schools of pure and applied science have been organized in Europe as essential to the best advancement of industry and civilization, and have been everywhere attended by the most flattering results. Great Britain is feeling deeply the necessity of similar institutions to her own industrial progress, and is moving strenuously for their immediate establishment.

Together with the schools of science and their collections, various establishments for the manufacture of models and apparatus were visited, and purchases were made of greater or less extent from those of Schröder at Darmstadt, Pistor & Martins, Siemens, Borchardt, and Schotte of Berlin, Winter of Vienna, Koenig, Duboscq, Hofmann, Ruhmkorff, Hempel, Alverniat, Gaiffe and Carré of Paris, Geissler of Bonn, and others.

Among the mechanical models and apparatus procured may be specified a choice selection from the establishment of Schröder at Darmstadt, embracing among others, Fourneyron's Turbine, various other models of wheels and teeth of wheels, diagram models of the forms of teeth, cross heads and connecting rods, axles and *shafts, couplings*, brakes, steps, pillow-blocks and hangers, cranks,

bolt-joints, valve gearing and sectional engine, geometrical solids, roof truss, etc., etc. From the collection of Prof. Zeuner at Zurich, were copied, four large models for the study of link and valve motions, various models illustrating the elements of mechanism—glass, spur, bevel, band, frictional, differential, etc., elliptic and irregular wheels, cams, parallel motions, boiler and fire-box joints, etc., etc. A hydrostatic press of 20,000 lbs. power is among the mechanical apparatus. The physical apparatus includes, in optics, Duboscq's lantern, *port lumiere*, solar microscope, polarizing and projection apparatus, Norremberg's polarizing apparatus, with collections of crystals and other objects, lenses, mirrors, prisms, etc., etc.; in acoustics, Koenig's apparatus for the analysis of sounds by vibrating flames, Helmholtz's resonators, sets of diapasons, with apparatus for the combination of vibrations by the optical and graphic methods of Lissajous and Dessains, organ pipes and bellows, with manometric flames, vibrating plates, sonometer, etc.; in electricity and magnetism, Winter's plate machine, electrophorus, battery, and other accessories, Holtz' electrical machine by Borchardt, of extraordinary power, Ruhmkorff's coil, Geissler's tubes, with electro-magnetic rotation-apparatus, Siemens' magneto-electric machine, electro magnets, galvanometers, thermo-electric pile, etc. In heat and general physics, Carré's freezing apparatus, Masset's steam globe, manometers, thermometers, eolipile, water hammer, hydrostatic balance, pump models, Sprengel's mercurial air-pump, collision balls, apparatus illustrating various forms of wave motion in liquid and elastic fluids, Pistor & Martins' reflecting circle, precession apparatus, etc., etc. In geography, a set of Schotte's Relief maps, and several topographical charts were procured in Berlin.

Only a portion of the fund for models and apparatus has yet been expended; additions are to be made to the collection from time to time, as they are needed, or can be procured.

The apparatus procured in Europe last summer has all been received, most of it in good order, but some of the cases considerably damaged by rough handling, and in consequence of defective packing.

Much trouble was experienced at the New York Custom House, in consequence of an attempt to collect 45 per cent. duty on all apparatus containing any portion of brass, under the law of Feb., 1869, levying that amount on "copper and manufactures of copper." It was only after much trouble, and a journey to Washington, for an appeal to the Treasury Department, that this imposition was avoided, and the goods passed at 15 per cent. duty, the legal amount for colleges.

Most of the mechanical models were passed free by the Custom House authorities, under the law relating to models of mechanical inventions. Several cases were, by order from the Treasury Department, forwarded in bond, unopened, to the New Haven Custom House, in order to avoid the danger of breakage from the opening and repacking of delicate apparatus in New York.

Besides the apparatus and models referred to, books, to the amount of upwards of $1,000, were purchased for the library of the school, chiefly in the departments of Mechanics, Engineering, and Natural History,—the larger portion in the two former.

Incidental to the direct object of this trip, and contributing in no small degree to the pleasure and advantage derived from it both to Prof. Newton and myself, was the opportunity of making the acquaintance of many of the distinguished cultivators of science abroad, and of studying the various institutions of science and letters, so far as was practicable in the limited time allowed. The opportunity of attending the meeting of the British Association for the Advancement of Science at Exeter, was by no means among the least of the incidental privileges referred to, and the recollection of the cordial and unstinted hospitality and the uniform courtesy which we experienced at various points, both in Great Britain and on the continent, will not only endear to us the many friends whom it was our good fortune to meet, but also leave a deeper and more abiding conviction in our minds that science knows no country, and that the more it is cultivated and diffused, the more it will unite in a common bond of sympathy and interest the people of all lands.

Yours respectfully,

CHESTER S. LYMAN.

Additions to the other Scientific Collections.

I. ZOOLOGICAL DEPARTMENT.

PROF. A. E. VERRILL, CURATOR.

The additions to the Zoölogical collections have been numerous and important during the past year. Particular efforts have been made to complete, so far as possible, our collections of the marine animals of America, and especially of the Pacific coast. Special attention has also been directed to the enlargement of the collection of skulls and skeletons of vertebrate animals.

Among the most important contributions to the museum, are several very extensive collections of the shells, corals, echinoderms, etc., of the Gulf of California, which we owe to Capt. James Pedersen, who still continues to be one of our best friends.

Other important additions are a collection of the shells, etc., of the west coast of Florida, from Col. Ezekiel Jewett; a collection of shells, from the same region, from W. T. Coons, Esq.; a large collection of shells from the rivers of Alabama, purchased of Dr. E. R. Showalter; an entire young sea-elephant, several penguins, etc., from Desolation Island, presented by R. H. Chapell, Esq.; an excellent collection of insects from South Africa, sent by Mr.

Sarah Abraham, and collected by her sons; and an authentically named series of European and other foreign shells, from Dr. P. P. Carpenter.

From the Museum of Comparative Zoölogy, through Mr. L. F. de Pourtales, we have received a valuable series of typical specimens of the corals collected and described by him, during the investigation of the deep-sea faunæ of the Gulf Stream, by the United States Coast Survey.

Prof. James Orton has presented a small but valuable collection of reptiles from the upper Amazon, including several species recently described by Prof. Cope. From M. Henri de Saussure, we have received in exchange a valuable typical collection of Orthoptera, mostly European and Mexican.

The work upon the collection has advanced as rapidly as could be expected with the small number of workers that we have had. During the year, seven special students have received instruction in the Zoölogical laboratory, but several of them have been at work for but a short time, and have, therefore, not been able to aid much in the arrangement of the collection, yet some of them have given important assistance. Mr. S. I. Smith, who is the only regular assistant, has devoted a great amount of labor to the identification and labeling of the Crustacea, and has published descriptions and figures of many of the new and rare forms in the Transactions of the Connecticut Academy of Sciences, and the Proceedings of the Boston Society of Natural History. He has also identified and labeled collections of Crustacea sent for examination by the Peabody Academy of Science, Salem, Mass.; Boston Society of Natural History; and Dr. A. S. Packard. He also published last autumn, in the Transactions of the Connecticut Academy, descriptions of the Brazilian Crustacea, collected by Prof. C. F. Hartt. He has, in addition, taken charge of the collection of insects, which has been considerably increased, and is in an excellent state of preservation. Professor Verrill has devoted a large amount of time to the identification and labeling of the collections of shells, which are now quite extensive, and particularly rich in those from the Pacific coast of tropical America. Some of the new species of that region have been described by him in the American Journal of Science. He has also continued the investigation of the echinoderms and corals, and has published descriptions and figures of many of the little known and new species in the Proceedings of the Boston Society of Natural History; Communications of the Essex

Institute; Transactions of the Connecticut Academy; and in a series of articles commenced in the American Journal of Science, entitled Contributions to Zoölogy from the Museum of Yale College. In the Proceedings of the American Association for the Advancement of Science, he has published a monograph of the American Phyllopod Crustacea, of the family, *Branchipidæ*. At the January meeting of the Connecticut Board of Agriculture, he gave two lectures on the Parasites of man and domestic animals, and has prepared an extended report on the subject, illustrated by numerous figures, for the State Report. The destruction by fire of the unfinished volumes of the Transactions of the Connecticut Academy, has obliged him to devote a great amount of time and labor to the reprinting of the series of papers previously published under the title of "Notes on the Radiates in the Museum of Yale College," and has prevented the issue of the last and most important of the series. This is a monograph of the corals and polyps of the west coast of America, with numerous plates. All these articles are based on specimens in the museum.

Mr. Wm. R. Belknap has given valuable assistance in labeling and cataloguing the fresh-water shells, and Mr. Edgar F. Verrill, during the short time that he remained, gave important aid in cataloguing and labeling various collections.

Mr. L. Shierholtz has been employed for a considerable time, in the laboratory, making drawings on stone and wood for the various publications relating to the collections.

Our thanks are especially due to Dr. P. P. Carpenter, who has taken great interest in our collections of shells, and has labeled and returned the *Chitonidæ*, and other shells sent to him for examination, and who, while on a short visit to this country, devoted considerable time to determining some of the most difficult shells from the Gulf of California.

Mr. S. H. Scudder has identified and returned our New England butterflies.

The system of exchanges with other museums has been considerably extended during the year, and quite a number of additional collections are now nearly ready to be sent away.

LIST OF DONATIONS.

W. G. Abbott (S. S. S. 1869)—Insects, shells, etc, New Haven, ... 50
Wm. A., A. J., and Chas. E. Abraham.—Insects, 69 species; 407 specimens; land shells, 4 species; skin of porcupine, all from South Africa, near Natal, 480
Joseph S. Adam (S. S. S).—*Gelasimus minax*, New Jersey, ... 1
E. B. Barbor, New Haven.—Insects, Cuba, 4 species; lizard, Cuba, ... 5

eecher (Y. C. 1872).—Male *Gelasimus pugnax* Smith, with equal
n unique specimen, ... 1
ıap (S. S. S. 1869).—Insects, Kentucky, 65 species; insects, New
tc., 11 species; Hippa, New Jersey; shells, etc., Kentucky, 8 spe-
ects, Texas, 2 species; reptiles, New Jersey and New Haven, 3
fish, 2 species, ... 243
Brewer.—Insects from the Rocky Mountains, 45 species; *Gordius*,
4, ... 159
ge, Chicago.—*Artemia fertilis* V., and larvæ of *Ephydra*, Great
3, ... 7
stead (Y. C. 1855).—Skeleton and stuffed leg of alligator, from
..... 2
Chapell, New London.—Fœtal sea-elephant, teeth of sperm whale,
penguins, 3 species, from Desolation Island; Crustacea, 3 species,
4 species, from the Gulf Stream, ... 59
erton.—Shells from Brazil, 4 species, ... 4
sey (S. S. S. 1869).—Crustacea, Long Island Sound, 2 species, ... 4
Mullica Hill, N. J.—Tail of Sting-ray, from Cape May, ... 1
ons, Florida.—Shells. 142 species; Crustacea, 6 species; Echino-
species; birds' eggs, 1 species, ... 1080
ry, Middletown.—Parasitic worm from hog, (*Sclerostoma pinguicola*
..... 4
gett, New Haven.—Larvæ of Ailanthus silk-worm; shells, crusta-
Ophiura, etc., Long Island, 10 species; young rats, New Haven, 120
, Washington, D. C.—Corals, Japan, Burmah, California, 4 species;
n, Japan, ... 34
s D. Dana.—Fresh-water sponges, Bombay, 6 species; Crustacea,
Islands, 5 species; long oysters, Stony Creek; part of expense of
ı purchased of Dr. Showalter, ... 52
Dickinson (S. S. S).—Skull of deer from California. 1
winelle (S. S. S).—Deformed claws of *Callinectes*, Baltimore, ... 2
C. Eaton.—Insects, New Haven and Utah, 4 species; *Artemia*
errill, from great Salt Lake; work of beavers, ... 59
vards, San Francisco, Cal.—Crustacea, California, New Zealand,
ı, 18 species; starfishes, New Zealand and California, 3 species;
ı, 7 species; Bryozoa, 9 species; shells, New Zealand, 11 species, 178
ı, New Haven.—Larva of *Smerinthus Abbottii*, New Haven, ... 1
, Portland, Me.—*Ophiura olivacea*, North Carolina, ... 4
ll.—Basket-worm on red cedar, Birmington, N. J. 20
rt (Y. C. 1869).—*Serpula*, Fire Island, ... 1
fall, Columbus, Miss.—Skulls of turtles, Tombigbee River, ... 2
ger (S. S. S).—*Artemia gracilis* V., New Haven; insects, 38 species,
ven; skeleton of cow, Oxford, Conn.; skulls of fishes, 2 species,
urtle, 1 species; embryonic kittens, New Haven, ... 113
er, Oxford, Conn.—Gape-worm (*Syngamus trachealis*), from wind-
chicken, ... 25
Hartt, Ithaca, N. Y.—Crustacea, Brazil, 21 species, ... 58
Hayden, Washington.—Skulls of beaver, prairie-wolf, badger, go-
., from Colorado, ... 7
x, New Haven.—Fish, New Haven, ... 1
Buren Hoes (S. S. S).—Cuttle fish and Luna moth from New
..... 2
Holmes, Charleston, S. C.—Skull of large turtle, from Mississippi
..... 1
kiss.—Insects, 47 species; and fishes, 1 species, China, ... 172
Hubbard, New Haven,—*Tænia mediocanellata*, ... 1
uffnagle, New Hope, Pa.—Skull of Bengal tiger, ... 1
(S. S. S. 1869).—Bat, New Haven, ... 1
kson.—Corals from the Red Sea. 4 species, ... 5
edy (S. S. S.)—Fresh-water shells, Montreal, 2 species; Astacus,
1; embryo dog-fish, reptiles, crustacea, New Haven, ... 34
sley, New Haven.—Beetle with its parasitic mites, New Haven, .. 50

Chas. B. Koon (S. S. S.)—Large moths (*Samia Cecropia* and *Tropea Luna*), New Haven; Cicada, Auburn, N. Y., 4
Mrs. Lloyd—Butterflies from South Africa, 6 species, 17
Prof. O. C. Marsh.—Three wild turkies, fresh; herring gull, grouse, quail, prairie hen, woodcock, snipe, fresh; skull of opossum; skulls and jaws of fishes, 7 species, and skin of rattlesnake from Charleston, S. C., collected by Andrew Nolan; skeletons of turtle, horned toad, and siredon, purchased of A. C. Klein, 44
Horace Mansfield, New Haven.—Large and rare moth (*Eacles imperialis*), New Haven, 1
J. G. Meirs.—Skeleton of hawk and snapping turtle, from Hornerstown, N. J., 2
G. D. Miller (Y. C. 1870).—*Telea Polyphemus*, New Haven, 1
Dr. W. Newcomb, Ithaca, N. Y.—Pennatula (*Leioptilum undulatum* Verrill), of Fonseca, 1
Prof. James Orton, Vassar College,—Ophidians, 7 species; Saurians, 4 species; Batrachians, 3 species, all from the upper Amazon, 14
Prof. L. R. Packard.—Insects, New Haven, 2 species, 5
Capt. James Pedersen.—Shells from the Gulf of California, 225 species; Echinoderms, 23 species; corals and Gorgonidæ, 20 species; Crustacea, 6 species, 4281
Prof. G. H. Perkins (S. S. S. 1869).—Turtle, 1 species; shells, 17 species, from New Haven and vicinity; *Artemia gracilis*, Charlestown, Mass., 310
Mrs. L. Pierpont, Fair Haven.—Flounder, with both sides similar, from New Haven, 1
Capt. M. S. Porter, New Britain.—*Euplectella speciosa*, East Indies. 1
Prof. C. U. Shepard, Jr., Charleston, S. C.—Alligator skeleton; rattle-snake; skull and vertebræ of turtle; trunk-fish, 6
Dr. G. H. Sherman (S. S. S).—Skeleton of cat, 1
S. I. Smith (S. S. S. 1867).—Insects, 80 species; reptiles, 2 species; bats, 2 species, New Haven, 432
Dr. L. A. Thomas, New Haven.—Lump-fish, New Haven, 1
U. S. Treat, Eastport, Me.—Rare starfish (*Hippasteria phrygiana*) Eastport, Maine, 1
Prof. A. E. Verrill.—Insects, 70 species; marine invertebrates, 40 species; bats, 1 species, New Haven; land-shells, N. Carolina, 6 species; marine shells, Casco Bay, 12 species; reptiles and fishes, New Haven, 8 species; skulls of fish and mammals, New Haven, 834
A. E. Verrill and S. I. Smith.—Insects, Norway, Me., 15 species, 45
Edgar F. Verrill.—Insects, 65 species, New Haven, 104
Prof. A. M. Wheeler.—Bird and butterfly, New Haven, 2
Dr. M. C. White, New Haven.—Human muscles, containing *Trichina Spiralis*, 2
W. W. White, Cheyenne.—Bird-skins, 2 species, 4
H. F. Whitman (S. S. S. 1869).—Insects, New Haven, 23 species, 39
H. S. Williams (S. S. S. 1868).—Reptiles in alcohol, 9 species; skeletons and skulls of alligators and turtles. 3 species; fishes; insects, Crustacea, 9 species; shells, 56 species; and Echinoderms, Polyps. etc., 6 species, all from Florida; insects, 7 species, New Haven, 613
F. E. Willets (S. S. S. 1869).—Snake (*Ophiobolus eximius*), Mt. Carmel, 1

RECEIVED IN EXCHANGE.

Dr. P. P. Carpenter, Montreal, Canada.—Shells, European, East Indian, etc., 424 species; *Chitons*, 4 species, 1102
Chicago Academy of Sciences.—Typical specimens of *Gelasimus subcylindricus* Stimp.; Gorgonidæ, Gulf of California, 5 species, 6
Prof. A. Hurd, Knox College.—Shells from Sherbro Island, West Africa, 46 species; Echinoderms from Sherbro Island, 3 species, 372
Col. E. Jewett, Utica, N. Y.—Shells from West Florida, 144 species; Crustacea, 8 species; sponge, 1 species; shells, New Zealand, 6 species, 1280
Museum of Comparative Zoology.—Echinothrix aperta A. Ag., type, from the Society Islands; deep-sea corals from the U. S. Coast Survey explorations of the Gulf Stream, types of Pourtales, 18 species, 26
Peabody Academy of Sciences, Salem, Mass.—Phyllopod Crustacea, 2 species, 6

Saussure, Geneva, Switzerland.—European Orthoptera, 80 spe-
ıtacus, Europe, ... 240

OBTAINED BY PURCHASE.

brewster, Boston, Mass.—Skeleton of boa, ... 1
ger.—Skeleton of young lamb, ... 1
Showalter.—Fresh-water shells from Alabama; Gasteropods, 240
Lamellibranchs, 116 species, ... 1560
Ward, Rochester.—Skeletons of Tapir and Llama, ... 2
us.—Sponges, West Indies; fishes, 7 species; Crustacea, 7 species;
1 species; insects, 19 species, from China, ... 124

COLLECTIONS SENT IN EXCHANGE.

knap, Louisville, Ky.—Shells, 16 species, ... 26
iety of Natural History.—Echinoderms and corals, 19 species, ... 22
Carpenter, Montreal.—Chitonidæ, 21 species, ... 40
cademy of Sciences.—Crustacea, 14 species; Echinoderm and corals,
es, types, ... 102
l Jewett, Utica, N. Y.—Shells, 100 species, ... 338
t Kölliker, Wurzburg, Bavaria.—Echinoderms, corals, and Gorgon-
species, types, ... 24
ütken, for the *University Zoölogical Museum*, Copenhagen.—Echino-
nd corals, 13 species, types, ... 19
Comparative Zoölogy, Cambridge, Mass.—Echinoderms, 4 species,
shells, 5 species, ... 24
cademy of Sciences, Salem, Mass.—Crustacea, 26 species; Echino-
species, ... 81
. Perkins, Burlington, Vt.—Shells, 16 species, ... 67
de Saussure, Geneva, Switzerland.—Crustacea, 38 species, ... 78
. Stearns, Patamula, Cal.—Shells, 89 species, ... 664
iams (S. S. S.).—Shells, 31 species, ... 80
Winslow, Danville, Ill,—Shells, 64 species, ... 313

2. Geological Department.

Prof. O. C. Marsh, Curator.

ıdditions to the Geological Museum of Yale College during
t year have been numerous and important, particularly
donations and purchases. Considerable progress also
ɔguing and preparing for study the collections of verte-
mains has been made by Mr. H. S. Williams, Assistant
epartment, and by Mr. O. Harger, special student, who has
l efficient service in the work. An effort has also been
ıring the past year to increase the osteological collection
t species, more especially to facilitate the investigation of
e series of extinct vertebrates now belonging to the Uni-

Further additions to this section of the Museum will be
ɔeptable.

g the more important gifts to the Museum may be men-
he cast of the gigantic *Megatherium Cuvieri* which was
d by the Class of 1869, at their graduation. The original
instructive specimen was discovered in 1831, in the Post-
deposits of Buenos Ayres, and is now in the British

Museum. Another important addition to the Cabinet is a valuable collection of Jurassic, Cretaceous, and Tertiary fossils from various English localities, recently presented by Pliny Jewell, Jr., Esq., of Hartford. The Museum has also been enriched by an interesting series of vertebrate fossils from the Tertiary of France, the gift of Professor E. Lartet, of Paris.

The acquisitions during the past year from the Marl region of New Jersey have been very important, and demand especial recognition. The most numerous and valuable of these have been presented to the Museum by the well known Cream Ridge marl Company, through John G. Meirs, Esq., one of the Directors, to whose personal efforts in preserving specimens of interest the University and science are greatly indebted. Among the most important gifts from this source may be mentioned the original specimens of several new genera and species of Birds, Reptiles, and Fishes, which have been recently described by the Curator. A most interesting and valuable collection of Cretaceous vertebrates, including some new to science, has also been presented to the Museum during the past year by the West Jersey Marl Company, through the Superintendent, I. C. Voorhies, Esq. A very fine series of similar fossils has, moreover, been received from J. C. Gaskill, Esq., Superintendent of the Pemberton Marl Company. From the Tertiary green-sand of New Jersey, interesting collections have been presented by Wm. E. Barrett, Superintendent of the Squankum Marl Company, and also by the Squankum and Freehold Company, through the Superintendent, Major A. A. Yard.

DONATIONS RECEIVED DURING THE PAST YEAR.

Dr. W. S. Kimball, Eatontown, N. J.—Tertiary and Cretaceous fossils from Monmouth Co., N. J., ... 25

James H. Taylor, Esq., Charleston, S. C.—Vertebrate remains from S. C. phosphate beds, ... 30

Stuart Phelps, Esq., (Y. C. Class of 1869).—Lower Silurian fossils from Beloit, Wis., and Rockford, Ill., ... 50

Dr. H. C. Chapman, Philadelphia.—Tertiary fossils from N. J., ... 10

Professor E. Lartet, Paris.—Tertiary and Post Tertiary fossils from France, ... 50

John G. Meirs, Esq.—Cretaceous fossils from Monmouth Co., N. J. 170

Cream Ridge Marl Co.—Fossils from middle and lower Marl bed of Hornerstown, New Jersey, received through John G. Meirs, Esq., ... 950

John M. Edwards, Esq., Cincinnati, O.—Lower Silurian fossils from near Cincinnati, ... 30

Prof. O. C. Marsh, (Yale College).—Fossils from various American and European localities, ... 1120

O. B. Kinne, Esq.—Tertiary fossils from Squankum, N. J., ... 50

S. S. Strong, Esq., Morris, Ill.—Carboniferous plants from Grundy Co., Ill., ... 510

Hon. Charles H. Conover.—Fossils from Marlboro, Monmouth Co., N. J., ... 10

Prof. F. H. Bradley, (Y. C. Class of 1863), Knoxville, Tenn.—Various fossils and casts of Trilobites, ... 25

Dr. J. C. Thompson.—Post Tertiary fossils from Manalapan, N. J., ... 5

E. C. Manning, Esq., Manhattan, Kansas.—Horse teeth from near Marysville, Kansas. 2
Pemberton Marl Co.—Cretaceous fossils from Birmingham, N. J., received through J. C. Gaskill, Esq., Supt., ... 230
Richard Laird, Esq.—Cretaceous fossils from Marlboro, N. J., ... 15
Dr. P. D. Knickern.—Tertiary and Post Tertiary fossils from Shark River, N. J., ... 27
Rev. E. O. Dunning, (Y. C. Class of 1832).—Devonian and Carboniferous fossils from Va., ... 18
Hon. Richard F. Stevens, Trenton, N. J.—Reptilian remains from West Jersey Marl Co's. pits, ... 15
Rev. J. T. Beekman.—Cretaceous fossils from Middletown, N. J., ... 20
Samuel Coit, Esq., Hartford.—Lepidodendron from Western Va., ... 1
West Jersey Marl Co.—Cretaceous fossils received through I. C. Voorhies, Esq., ... 420
H. C. Kingsley, Esq., (Yale College).—Ammonite from Lias of Ireland, ... 1
J. Dubois Smock, Esq.—Vertebra of *Mosasaurus* from Holmdel, N. J., ... 1
Charles H. Johnson, Esq.—Cretaceous fossils from Birmingham, N. J., ... 10
Shaler & Hall Quarry Co., Portland, Ct.—Specimens of footprints received through Geo. Gillem, Esq., ... 10
Charles M. Bruere, Esq.—Cretaceous fossils from Upper Freehold, N. J., ... 50
Rev. H. H. Beadle, (Y. C. Class of 1862).—Miocene fossils from Shiloh, N. J., ... 20
Squankum and Freehold Marl Co.—Eocene fossils received through Major A. A. Yard, Supt, ... 15
Class of 1869.—Cast of *Megatherium Cuvieri*, ... 1
William Van Schoick, Esq.,—Cretaceous fossils from Monmouth Co., N. J., ... 16
James Stevenson, Esq., Washington, D. C.—Fossils fishes, from the Tertiary of Wyoming Territory, ... 35
Richard M. Ware, Esq., Mullica Hill, N. J.—Cretaceous fossils from N. J., ... 20
Prof. Charles U. Shepard, Jr., (Y. C. Class of 1863), Charleston, S. C.—Fossil Vertebrates from S. C. phosphate beds, ... 50
Hugh Hurley Esq.—Fossils from Tertiary of Shark River, N. J., ... 35
Austin Hurley, Esq.—Tertiary fossils from Monmouth Co., N. J., ... 20
Rev. Greville I. Chester, Newport Pagnet, England.—Jurassic and Tertiary fossils from various English localities. 50
Frank H. Coles, Esq., Mullica Hill, N. J.—Tertiary fossils from Aquia Creek, Va, ... 10
Major E. Willis, Charleston, S. C.—Fossils from phosphate beds of S. C., ... 75
Martin Van Harlingen, Esq., (Sheffield S. S., 1864).—Fossils from Tertiary and Cretaceous of N. J., ... 5
Dr N. A. Pratt, Charleston, S. C.—Fossils from S. C. phosphate beds, ... 25
Dr. W. W. Memminger, Charleston. S. C.—Vertebrate fossils from phosphate beds of Cooper River, S. C., ... 20
Eli K. Ale, Esq., Mullica Hill, N. J.—Cretaceous fossils from N. J., ... 10
William E. Barrett, Esq.—Fossils from pits of Squankum Marl Co., N. J., ... 17
C. C. Coe, Esq.—Vertebrate fossils S. C. phosphate beds, ... 27
Dewitt C. Shafto, Esq.—Tertiary fossils from Shark River, N. J., ... 48
T. W. Clark, Esq.—Cretaceous fossils from Swedesboro, N. J., ... 11
Nicholas Waln, Esq—Reptilian and bird remains from the Cretaceous of Hornerstown, N. J., ... 35
George C. Murray, Esq., (Y. C. Class of 1845).—Shark tooth from Eocene of N. J., ... 1
John R. Dukes, Esq., Charleston, S. C.—Vertebrate fossils from Ashley River phosphate beds, ... 40
Richard Pancoast, Esq., Mullica Hill, N. J.—Cretaceous reptilian remains from N. J., ... 3
Phiny Jewell, Jr., Esq., Hartford, Ct.—Jurassic, Cretaceous and Tertiary fossils from England, ... 1000
Dr. Edwin Field.—Cretaceous fossils from Monmouth Co., N. J., ... 310
Colin B. Meirs, Esq., Upper Freehold N. J.—Reptilian remains from N., J., ... 3
Edward B. Woodward, Esq.—Post Tertiary fossils from Upper Freehold, N. J., 2
F. B. Meek, Esq., Washington, D. C.—Carboniferous fossils from Nebraska, ... 12

John G. Hummel, Esq.—Miocene fossils from Shiloh, N. J., 5
Isaac H. Turner, Esq.—Reptilian remains from near Swedesboro, N. J., 2
J. V. Dickinson, Esq.—Cretaceous fossils from Woodstown, N. J., 5
B. Waterhouse Hawkins, Esq.—Cast of femur of Dinosaurian reptile from N. J., 1
Prof. J. F. Tarrant.—Cretaceous fossils from Ala. and Miss., 10
Gilbert Agres, Esq.,—Tertiary fossils from Shiloh, N. J., 14
O. C. Herbert, Esq.—Cretaceous fossils from Monmouth Co., N. J., 6
Prof. W. C. Kerr, Raleigh, N. C.—Specimens of *Palæotrochis* from N. C., 25
Henry Ware, Esq.—Miocene fossils from Shiloh, N. J., 17
Capt. Edward L. Stratton, Mullica Hill, N. J.—Cretaceous fossils from N. J., 30
George W. Shafto, Esq.—Tertiary and Post Tertiary fossils from Shark River, N. J. 72
John Eli Shafto, Esq.,—Tertiary fossils from Monmouth Co., N. J., 9
George D. Miller, Esq., (Y. C. Class of 1870).—Fossils from various localities, 10
J. P. Pringle, Esq., Charleston, S. C.—Fossils from Ashley River, S. C., 5
Benjamin F. Lee, Esq., Philadelphia.—Fossils from West Jersey Marl Co., 15
William L. Gibson, Esq., Alloway stown, N. J.—Fossils from Cretaceous of N. J., 2
Samuel H. Mathews, Esq.—Cretaceous fossils from Colts' Neck, N. J., 8
John Keyer, Esq., N. J.—Fossils from near Mullica Hill, N. J., 10
T. M. Stoughton, Esq., Gill, Mass.—2 slabs of fossil footprints from Conn. River Sandstone, 2
Hon N. T. Stratton.—Cretaceous fossils from Mullica Hill. N. J., 7
Prof. F. V. Hayden, Washington, D. C.—Tertiary and Cretaceous fossils from Wyoming and California, 12
James White, Esq.—Post Tertiary fossils from Shark River, N. J., 10
Burlington County Marl Co., Vincentown, N. J.—Eocene fossils received through John Cook, Esq., Supt., 10
Prof. James D. Dana, (Yale College).—Cretaceous and Tertiary fossils from Ala., 250
John Hendrickson, Esq.—Cretaceous fossils from Mullica Hill, N. J., 15
Edward. L. Stratton, Esq., Mullica Hill, N. J.—Reptilian remains from the Cretaceous of N. J., 20
Dr. William M. White, Fair Haven, Ct.—Cretaceous fossils from Wyoming, 10
Frank C. White, Esq., Fair Haven, Ct.—fossils from Wyoming, 6
Daniel G. Hunt, Esq.—Fossils from Colts' Neck, N. J., 12
William Earnest, Esq., Hornerstown, N. J.—Cretaceous fossils from N. J., 9
Prof. W. H. B. Thomas, Mt. Holly, N. J.—Cretaceous and Tertiary fossils from Burlington Co., N. J., 17
Rev. R. E. Hawley.—Lower Silurian fossils from Ohio, 50
Joseph Jessup, Esq., Mullica Hill, N. J.—Reptilian remains from N. J., 25
John Dunlop, Esq., Mullica Hill, N. J.—Reptilian remains from N. J., 6
Thomas D. Dotterer, Esq., Charleston, S. C.—Fossils from Ashley River phosphate beds, 62
Samuel W. Loper, Esq., Durham, Ct.—Fossils from Conn. River Sandstone, 5
Major A. J. Smith.—Eocene fossils from Farmingdale, N. J., 19
John C. Turner, Esq.—Cretaceous fossils from Hurffville, N. J., 10
Benjamin L. Moore, Esq.—Reptilian remains from Gloucester Co., N. J., 5
Williams Middleton, Esq., Charleston, S. C.—Fossils from phosphate beds of Ashley River, S. C., 13
Prof. F. S. Holmes, Charleston, S. C.—Various fossils from S. C., 27
George Allen, Esq., Mullica, N. J.—Cretaceous fossils from N. J., 8
Charles J. Folwell, Esq.—Reptilian remains from Mullica Hill, N. J., 6
Frank E. Taylor, Esq.—Fossils from Charleston phosphate beds, and bird remains from Peru, 27
J. S. Thompson, Esq.—Cretaceous fossils from Mullica Hill, N. J., 11
H. F. Baker, Esq., Charleston, S. C.—Fossils from Ashley and Wando Rivers, S. C., 23
William H. Guildersleve, Esq.—Vertebrate remains from Cooper River phosphate beds, S. C., 97
Rev. J. M. Stone, Hanover Ill.—Lower Silurian fossils, 50
Simons Lucas, Esq.—Fossils from near Charleston, S. C., 8

unyan, Esq.—Cretaceous fossils from near Mullica Hill, N. J., ... 4
Sellery. Esq., Philadelphia.—Fossils from phosphate beds of Ashley , S. C., ... 20
P. Allen.—Fossils and rocks from Eastern Turkey, ... 20
eph A. Yates.—Cetacean remains from near Ashley River, S. C., ... 11
Bainard, Esq., Portland, Ct.—Specimens of drift from Conn. Valley, .. 2
mons, Esq.—Fossils from Wando River, S. C., ... 21
B. Mills, Esq.—Vertebrate remains from phosphate beds of Cooper , S. C., ... 35
liam Spillman, Enterprise, Miss.—Fossils from Alabama, ... 2
rry, Esq., (Y. C. Class of 1869).—Specimen of iron ore from Salisbury, ... 1
urns, Esq.—Fossils from Ashley River phosphate beds, S. C., ... 7
. W. Hilgard, Oxford, Miss.—Cretaceous and Tertiary fossils from 6
ish, Esq., Charleston, S. C.—Fossils from Wando River phosphate beds 5
orge Little, Oxford, Miss.—Cretaceous and Tertiary fossils from Miss, . 10
ttolingui, Esq.—Cetacean remains from Cooper River phosphate beds, ... 30
W. Johnson, (Yale College).—Tertiary fossils from Maryland and N. J. 20
rry, Esq.—Lower Silurian fossils from Ill, ... 25
K. Needham, Esq., (Sheffield S. S., 1869).—Geological specimens from , ... 2

COLLECTIONS OBTAINED BY PURCHASE.

rong, Esq.—Fossils from Coal measures Mazon Creek, Grundy Co., Ill., 720
mes Orton,—Post Tertiary fossils from Quito Valley, Equador, S. A., . 100
. A. Ward.—European fossils from various localities, ... 75
rewster, Boston. Mass.—European and American fossils, ... 45
W. Morgan.—Post Tertiary fossils from pampas of Buenos Ayres, ... 150
Howell, Esq., Nichols, N. Y.—Fossils from Tioga Co., N. Y., ... 350
R. Schowalter, Uniontown, Ala.—Cretaceous and Tertiary fossils from and Miss. 700
line, Esq., Philadelphia.—Various European fossils, ... 75
toughton, Esq., Gill, Mass.—Specimens of fossil footprints from Conn. Sandstone, ... 5
, Esq., Gill, Mass.—Footprints from Conn, River Sandstone, ... 48

3. Mineralogical and Metallurgical Museums.

Prof. George J. Brush, Curator.

following gifts have been received from the parties whose are specified in connection with each donation :

'ewell, Esq., Hartford, Ct.—A suite of specimens of crystallized sulphur and nti. in Sicily.
. M. Wheeler.—A collection of garnets in Mica-slate from Reading, Ct.
H. Clark, Esq.—Native sulphur from the island of Saba.
'acfarlane, Esq.—Purple copper ore from the Acton Mine, Canada.
Manufacturing Co., Castleton, Vt.—Specimens of slate and manufactured pencils.
Mathiessen & Hegeler, La Salle, Illinois.—Specimens of zinc-blende, calamine casted zinc ores.
An K. Payne, Knoxville, Tenn. Copper, iron, and manganese ores, from essee.
Childs, Esq., Dubuque, Iowa,—Lead ores and crystallized galena, from ique, Iowa.
Selden, Esq.—Steatite, from Vermont.

Geo. D. Roseberry.—(S. S. S. 1870).—Black-band iron ore, from Pottsville, Pa.
Prof. A. E. Verrill.—A collection of gold quartz, from Copp's and Wilson's Mines, Mecklenburg Co., North Carolina.
O. D. Allen, Esq.—Suite of iron and steel, illustrating the manufacture of Bessemer Steel, from the Freedom Iron and Steel Works, Lewistown, Pa.
J. H. Phillips, Esq., New Haven, Conn.—A collection of specimens of polished marble.
Capt. J. Pedersen.—Silver and lead ores, from Lower California.
Wm. Butcher's Steel Works.—Philadelphia, Pa., (received through B. S. Burton, S. S. S. 1864).—A collection of various brands of Swedish iron, and different qualities of steel.
Joseph Wharton, Esq., Philadelphia.—Crystallized furnace products from the Gap Mine Nickel furnaces.
Eliot Savage, Esq., West Meriden, Ct.—A specimen of an alloy of copper and manganese.
Adams' Express Co., (through W. Webb, Esq., Agent).—Specimens of apatite, from Burgess, Canada.
The Colwell's, Shaw & Willard's Manufacturing Co., New York, (through Mr. Torrey).—Specimens of new plumbers' joint and copper soldering tongs.

The collection of meteorites has been further enlarged by exchange during the current year, as, also, the collection of minerals, ores and furnace products.

4. Museum of Archæology and Ethnology.

The establishment of the Yale Museum of Archæology and Ethnology, and its prospects of future usefulness appear to have been fully appreciated during the past year by many of the friends of the University, and also very generally by those in this country who are interested in the sciences it is designed to foster. Its existence has, moreover, received a grateful recognition from several eminent Archæologists of Europe, who have promised assistance and co-operation. Professor E. Lartet of Paris, President of the International Archæological Congress, has already presented a most interesting and valuable series of specimens from the caves of Southern France, illustrating the Reindeer period of the early Stone Age, which he is now describing in his great work, *Reliquiæ Aquitanicæ;* and important contributions from other parts of Europe are expected at an early day.

The most important addition to the Museum of late from American localities is a large collection of human remains and implements of various kinds from some Mounds in East Tennessee which have recently been explored for this Department by Rev. E. O. Dunning, of the Class of 1832. This collection is of especial value, as it contains about forty authentic skulls of the "Mound builders," a careful study of which promises to settle several important questions in regard to this interesting prehistoric race

The exploration in the mounds of this region, so successfully commenced, as well as several other promising investigations of a similar character, cannot, unfortunately, be continued at present for want of funds. In this and other respects, the pressing need of generous subscriptions, or a permanent endowment for this new Musuem is keenly felt by all interested in the Archæology of the country.

To make the object of this Department of the University more generally known, the Circular originally issued is here essentially repeated.

Museum of Archæology and Ethnology.

This department of the College has been recently established in response to the rapidly increasing interest in questions relating to the origin, antiquity, and early history of Man. It has for its main object the formation of collections illustrating what is known of the aboriginal races of North and South America, both in prehistoric time, and during their subsequent progress toward civilization; and also, so far as may be necessary for comparison, of collections relating to the primitive races of other countries.

The facilities for collecting specimens relating to the early races of America are every year rapidly diminishing, and it is earnestly hoped that all friends of the College will lose no opportunity of securing for this new Museum objects of interest bearing upon the important branch of science it is designed to illustrate.

Among the articles which it is especially desirable to obtain are the following:

1. Implements of stone, such as axes, gouges, chisels, mortars, pestles, pipes, tomahawks, spear-heads, arrow-heads, &c.

2. Implements of copper or bronze, such as axes, chisels, spear-heads, knives, &c.

3. Articles of earthen-ware, such as images of any kind, vases, pots, pipes, &c.

4. Articles of dress, weapons, domestic utensils, &c., of the various tribes of North and South American Indians, and also of the Eskimos.

5. Images and sculptures, or casts of them, particularly those made by the early inhabitants of Mexico, Central America, Peru, and Chili.

6. Mummies, skeletons, or parts of skeletons, especially the skulls, of any of the above *named races.*

Specimens intended for the Museum may be sent to the care of Prof. O. C. MARSH. If possible, the exact locality of each article should be given.

DONATIONS RECEIVED DURING THE PAST YEAR.

Rev. John Avery, Lebanon, Ct.—Pair of Indian snow shoes,..... 2
John G. Meirs, Esq., Hornerstown, N. J.—Various stone implements from N. J.,..... 10
C. B. Fuller, Esq., Portland, Me.—Implements and animal remains from shell heaps of Casco Bay,..... 40
Rev. G. I. Chester, Bucks, England.—Shell implements from Barbadoes, and other antiquities,..... 15
Prof. E. Lartet, Paris.—Implements and animal remains from Caves of Southern France,..... 110
George Haines, Esq., Medford, N. J.—Various stone Implements from Burlington Co., N. J.,..... 10
H. E. Hotchkiss, Esq., New London.—Indian bow and arrows, and air gun, from Demarara, S. A.,..... 25
J. C. Gaskill, Esq., Birmingham, N. J.—Stone axes from N. J.,..... 3
Rev. E. F. Rockwell, Statesville, N. C.—Various Stone implements from N. C.,.. 72
Dr. P. D. Knieskern, Shark River, N. J.—Stone axes from Monmouth Co., N. J.,..... 3
C. Dickerman, Esq... Savin Rock, Ct.—Stone axe from Ct.,..... 1
George W. Shafto, Esq.. Shark River, N. J.—Stone axes from N. J.,..... 2
N. Robbins, Esq., Woodstown, N. J.—Stone implements from N. J.,..... 4
John Dubois, Esq., Freehold. N. J.—Stone axe from Monmouth Co., N. J.,... 1
Prof. George Little, Oxford, Miss.—Stone hoe from Miss.,..... 1
T. M. Stoughton, Esq., Gill. Mass.—Indian arrow heads from Turner's Falls. Mass.,..... 7
Nicholas Waln, Esq., Hornerstown, N. J.—Stone implements from N. J.,..... 3
Dr. Edwin Field, Middletown, N. J.—Stone implements from Monmouth Co., N. J.,..... 16
Prof. O. C. Marsh, (Yale College).—Various antiquities from American and European localities..... 220
Samuel W. Loper, Esq., Durham, Ct.—Stone implements from Ct.,..... 3
William E. Barnett, Esq., Farmingdale, N. J.—Stone axes from Squankum. N. J.,..... 2
William N. Foulks, Esq., Oakford, N. J.—Stone implements from N. J.,..... 3
Dr. J. Hall, Columbus, Miss.—Various stone implements from Miss.,..... 9
Richard Pancoast, Esq., Mullica Hill, N. J.—Stone arrow head from N. J.,... 1
William C. Shafto, Esq., Lower Squankum, N. J.—Stone axe from N. J.,..... 1
Prof. W. H. B. Thomas. Mt. Holly, N. J.—Various stone implements from Pa. and N. J.,..... 7
George D. Miller, Esq., (Y. C. Class of 1870).—Antiquities from Nova Scotia,. 5
John R. Keyer, Esq., Mullica Hill, N. J.—Stone arrow heads from N. J.,..... 5
Charles J. Folwell, Esq., Mullica Hill, N. J.—Stone pestle from N. J.,..... 1
Samuel Elkins, Esq.. Mullica Hill, N. J.—Indian arrow head from N. J.,..... 1
S. B. Borel. Esq., New Haven.—War club from South Pacific,..... 1
George S. Hoyt, Esq., Anapolis, N. S.—Indian arrow heads from N. S.,..... 5
Dr. N. A. Pratt, Charleston, S. C.—Human femur from phosphate deposits of Ashley River, S. C.,..... 1
Henry Ware, Esq., Shiloh, N. J.—Stone implements from N. J.,..... 5

ANTIQUITIES OBTAINED BY PURCHASE OR EXCHANGE.

A. C. Kline, Philadelphia.—Stone implements from European and American localities,..... 50
C. G. Brewster. Boston Mass.—Various stone implements and other antiquities, 37
Henry Davis, McGregor, Iowa.—Stone implements from Iowa,..... 30
Rev. E. O. Dunning, (Y. C. Class of 1832).—Human remains and various antiquities from the Mounds of East Tenn.,..... 300
Robert Howell, Nichols, N. Y.—Antiquities from Tioga Co., N. Y.,..... 20
Dr. E. R. Schowalter, Uniontown Ala.—Stone implements from Ala.,..... 25

Public Lectures.

The usual course of public lectures to mechanics and others was delivered in the months of February and March. The attendance was never before so uniformly large, and the expressions of interest on the part of the audience were such as to be highly gratifying to the lecturers. As heretofore the lectures were attended by men, most of whom are heartily interested in the practical aspects of science. The following was the programme:—

PROGRAMME.

I.	Monday, Feb. 7.	Introductory Lecture: Technical Education Here and Abroad,	Prof. Gilman.
II.	Thursday, " 10.	Profits,	Pres. Woolsey.
III.	Monday, " 14.	Great Salt Lake,	Prof. Eaton.
IV.	Thursday, " 17.	Improvement of Varieties of Animals and Plants,	" Brewer.
V.	Monday, " 21.	Domestic Insect Enemies,	" Verrill.
VI.	Thursday, " 24.	Electricity and Lightning Rods,	" Lyman.
VII.	Monday, " 28.	The Late Total Eclipse of the Sun,	" Norton.
VIII.	Thurs., March 3.	Voltaic Electricity and Magnetism,	" Barker.
IX.	Monday, " 7.	Chemistry of Stimulants,	" Johnson.
X.	Thursday, " 10.	Human Parasites found in food,	" Verrill.
XI.	Monday, " 14.	The English Language,	" Lounsbury.
XII.	Thursday, " 17.	The Rocky Mountains,	" Brewer.
XIII.	Monday, " 21.	Sodium and its Compounds,	" Mixter.
XIV.	Thursday, " 24.	Gearing,	" Lyman.

In addition to this course of lectures, Prof. Lyman soon after his return gave a familiar account of his journey in Europe, and exhibited to the friends of the school, some of the more interesting pieces of apparatus which he had purchased. A number of gentlemen from out of town attended this lecture.

In view of the importance of Drawing as a branch of instruction in a scientific school, the Board, in connection with Prof. Weir, of the Yale School of the Fine Arts, invited Mr. Charles C. Perkins of Boston, an American gentleman long resident in Europe, and well known as the author of two elaborate works on Italian and Tuscan sculpture, to repeat in New Haven a lecture which he had recently given in the Lowell Institute in Boston, at the instance of the American Association for the Advancement of Social Science. Mr. Perkins accordingly gave his lecture on "Art Education in America" before the Scientific School, andthe thanks of the Board were heartily given to him for this acceptable service.

Prof. Verrill lectured as heretofore before the State Board of Agriculture, at their annual meeting, which was held last winter in Middletown. Prof. Brewer, a member of that Board, likewise participated in the meeting.

Professors Brewer, Eaton and Gilman have lectured during the year before assemblages of teachers, and the latter has in Boston and elsewhere spoken on the subject of Scientific and Technical Education.

The teachers in New Haven have met in Sheffield Hall to hear a lecture from Prof. Morse of Salem, Mass.; and the meetings of the Connecticut Academy and of the American Oriental Society as in former years have been held in our library room.

United States Survey of the Fortieth Parallel.

In this connection it may also be mentioned that the United States Survey of the Fortieth Parallel, now engaged in preparing a report of observations made in the field during the last three years, has transferred its head quarters from Washington to New Haven, and is now established for the summer in the various rooms of Sheffield Hall. It is particularly gratifying to the professors to have an opportunity to extend the hospitalities of the school to the members of this exploring party, as the gentleman at its head, Mr. Clarence King, graduated here in 1862, and several of his associates have here for a longer or shorter time pursued their scientific studies.

Instruction and Instructors.

With the growth of the material resources of the school, it is never to be forgotten that the true test of success lies in the instruction here given. Whatever else the school may accomplish, it will fail of its chief end, if it fails to give a superior preparation for life to those young men who here resort for their education. Much thought is bestowed upon the courses of study here laid down, and as experience is gained in respect to education in scientific studies, and especially as the staff of instructors is increased, we may expect that higher results in scholarship will constantly be attained.

It is unfortunate that in some of the best preparatory schools of the country, candidates for admission to this department of Yale College find it difficult to obtain instruction in the moderate amount of Latin which we require for admission. We regard *this linguistic* discipline as very important, and earnestly urge

upon all who are to enter upon a scientific course of study with us, not to be deterred from the preliminary study of Latin. At the same time, in view of the difficulty to which we have referred, we are obliged in special cases to take into consideration the obstacles which each young man may have encountered.

We refer with pleasure to the increasing number of young men, already graduated, who come here to enter upon advanced scientific studies. The degree of Doctor of Philosophy, or of Civil Engineer, is conferred by Yale College upon such candidates as comply with certain required conditions. The number of post-graduate students during the current year has been twenty-eight; their specialities have been very different; great freedom of choice is permitted; and all the resources of the institution, in apparatus, laboratories, collections, etc., are at the service of those who need them. It seems to us that the positions of responsibility which are open to superior persons well trained in advanced scientific studies, have never been so numerons or so inviting as they are at present.

During the coming year, and henceforward, the school has reason to expect the services of an additional professor in the department of mechanical engineering. Prof. William P. Trowbridge, late Captain in the Engineer Corps of the United States Army, a graduate of the U. S. Military Academy at West Point in the class of 1848, and during the last five years one of the managers of the Novelty Iron Works in New York City, has accepted the overtures which have been extended to him to become a professor here. His appointment depends upon the Corporation of Yale College,—but there is no reason to doubt their favorable action on the nomination presented to them; and Professor Trowbridge will begin his instructions with the next Academic year. The school may be congratulated on thus securing the services of a gentleman who adds to a high degree of scientific attainment, a wide acquaintance with the practical applications of mathematical and mechanical principles.

During the past year, the instruction in English has been given by Mr. T. R. Lounsbury, a graduate of Yale College in 1859, who has for many years made a specialty of the study of the English language; and the instruction in French, relinquished by Professor Whitney, has been temporarily given by Mr. Josiah W. Gibbs, Ph.Dr., a graduate of Yale College in 1858.

An officer of the United States Coast Survey, R. M. Bache, Esq., has been detailed by the Superintendent, Prof. Benjamin Peirce, to engage in a topographical survey of the region around the harbor of New Haven, and there is reason to expect that students in Engineering properly qualified will thus have an opportunity during the coming year, to become acquainted with the field-work of this branch of the government scientific service.

ANNIVERSARY EXERCISES.

The annual reading of Theses and Prize Essays occurred July 19, 1869.

The following are the names of the successful candidates for degrees, and the titles of their Theses. Those marked with a star (*) were selected to be read in the evening.

CANDIDATES FOR DEGREES,

WITH TITLES OF THEIR GRADUATING THESES.

DOCTOR OF PHILOSOPHY.

WILBUR OLIN ATWATER, M.A. Wesl. Univ., *Brandon, Vt.* "On the proximate composition of several varieties of Indian Corn."

This thesis gives the amount of water, ash, albumenoids, fats, sugar, gum, dextrine and starch in several kinds of American Maize. The methods of analysis are described, and the results of other experiments embodied are discussed.

EDWARD THOMSON NELSON, B.A. Ohio Wesl. Univ., *Delaware, O.* "On the Molluscan Fauna of the later Tertiary of Peru."

This thesis gives the results of a critical examination of a collection of fossil shells from Zorritos, Peru, with descriptions of about twenty specimens new to science.

GEORGE HENRY PERKINS, B. A.. *New Haven.* "On the Molluscan Fauna of New Haven."

This is a critical review of all the marine, fresh water and land mollusca hitherto found in this region. Three new species and the living animals of many others not before studied are fully described.

CIVIL ENGINEER.

CHARLES KINNEY NEEDHAM, B.Ph., *Louisville, Ky.* Design for a Bridge.

BACHELOR OF PHILOSOPHY.

WILLIAM GREENE ABBOT (Select Course), *Norwich.* "On some New Aspects of the Labor Question."

*WILLIAM RICHARDSON BELKNAP (Select Course), *Louisville, Ky.* "On the Geographical Spread of Mohammedanism."

ROMAN AUGUSTUS BISSELL (Engineering), *Detroit, Mich.* "On Railroad Tunneling."

*Charles Augustus Brinley (Chemistry), *Hartford.* "On the Relations of Osmose and the Ash Ingredients to the Life of Plants."

Francis Dudley Buck (Chemistry), *New York City.* "On the Metallurgy of Zinc."

Andrew Dwight Chidsey (Select Course), *New Haven.* "On the Merits, Defects and Possible Improvements of the American Prison Systems."

Clarence Marcellus Clarke (Engineering), *New Haven.* "On the Water Supply of Cities."

Frederick Smillie Curtis (Mining Engineering), *Stratford.* "On the Sandstone Quarries of Portland, Conn."

* Augustus Jay DuBois (Engineering), *New Haven.* "A Critical Examination of the Water Works of New Haven."

*Joseph Robinson Folsom (Mining Engineering), *New Haven.* "On the Gold Placers of California."

*Albert Banks Hill (Engineering), *Redding.* "On Foundations in Water for Bridges."

Joseph Courten Hornblower (Engineering), *Paterson, N. J.* "On Ventilation."

*Nelson Powell Hulst, B.A. (Mining Engineering), *Alexandria, Va.* "On the Silver Region of Colorado."

*Edward Whiting Johnson (Select Course), *Norwich.* "On Strategy, as illustrated by the Opening of the Mississippi River, 1861–64."

Joseph Goodhue Kendall (Engineering), *New York City.* "On the Pneumatic Despatch."

* Charles Byron Koon (Engineering), *Auburn, N. Y.* "On Sewers."

Houston Lowe (Select Course), *Dayton, O.* "On England and Ireland."

Henry Hoyt Perry (Chemistry), *Southport.* "On the Salisbury Iron Mines."

* Charles Henrique Pope (Engineering), *Louisville, Ky.* "On the Utilization of Power in Machinery."

*Joseph John Skinner (Engineering), *Wallingford.* "On Intermittent Springs."

Robert Schuyler Van Rensselaer (Engineering), *Bordentown, N. J.* "On the Progress of Civil Engineering."

*Charles Alvah Weed (Chemistry), *Binghamton, N. Y.* "Analysis of a Mineral from West Rock."

William Robert White (Select Course), *Philadelphia, Pa.* "On the Anthracite and Bituminous Coal of the United States, and the English System of Coal Mining."

Horace Franklin Whitman (Select Course), *Philadelphia, Pa.* "On Light and its Peculiarities."

Willard Wendell Wight (Engineering), *Natick, Mass.* "On Bridge Construction."

Frederick Everett Willits (Select Course), *Glen Cove, N. Y.* "On some of the Changes now taking place in the English Language."

THE FOLLOWING PRIZES WERE ALSO AWARDED:

For Excellence in the Studies of Freshman Year.

First Prize, $30, JOSEPH FREDERICK KLEIN, *New Haven.*
Second Prize, $20, MANSFIELD MERRIMAN, *Plantsville.*

For Excellence in the Mathematical Studies of Junior Year.

A prize of $20, ARTHUR WOODS RICE, *West Meriden.*

For Excellence in the Engineering Studies of Senior Year.

A prize of $20, JOSEPH JOHN SKINNER, *Wallingford.*

For Excellence in the Select Course Studies of Senior Year.

A prize of $25, WILLIAM RICHARDSON BELKNAP, *Louisville, Ky.*

For Proficiency in Mineralogy.

A prize of $20, JOSEPH SAMPSON ADAM, *Canaan.*

For Proficiency in Metallurgy.

A prize of $20, NELSON POWELL HULST, B. A., *Alexandria, Va.*

For Excellence in the Modern Languages.

In *French*, a prize of $10, JOSEPH JOHN SKINNER, *Wallingford.*
In *German*, a prize of $10, JOSEPH JOHN SKINNER, *Wallingford.*

For the Best Essays in English on Assigned Themes.

(First and Second Prizes divided equally between the two competitors.)

A prize of $17.50, CHARLES AUGUSTUS BRINLEY, *Hartford.*
A prize of $17.50, FREDERICK EVERETT WILLITS, *Glen Cove, N. Y.*

LIBRARY AND READING ROOM.

The periodicals heretofore taken have been continued through the year, and some additions to the list have been made. A careful catalogue of all the mathematical and mechanical books belonging to the collection, including those purchased by Mr. Sheffield from Dr. Hillhouse, those bought in Europe by Prof. Lyman, and other purchases and gifts, is now in preparation and will probably be printed in order to facilitate as much as possible the advanced study of the Mathematical Sciences.

PROGRAMME OF STUDIES.

In consequence of the additions to the corps of instruction, and the necessary readjustment of the courses of study, the programme of studies for the year 1870–71 will be issued in a separate pamphlet, a little later than this report. Copies of this and other pamphlets, explanatory of the institution, may be obtained by addressing the Secretary, Prof. D. C. Gilman, or by application to any of the professors.

In the present connection it is sufficient to add that the courses *of study* have reference to three distinct classes of scholars; viz.

1. *University or Post-graduate students*—Those who have already raduated in a college or in a school of science, and who desire) pursue advanced courses of study with reference to the calling f professors or teachers, the pursuit of scientific investigations, tc., etc. The degree of Doctor of Philosophy, or of Civil Engieer, will be conferred by Yale College upon candidates who omply with certain required conditions. The number of postraduate students during the current year has been twenty-eight; ieir specialities have been very different; great freedom of choice permitted; and all the resources of the institution, in apparatus, iboratories, collections, etc. are at the service of those who need hem. The positions of responsibility which are open to superior ersons well trained in advanced scientific studies, have never been) numerous or so inviting as they are at present.

2. *Under-graduate students*—Those who desire to fit themselves y a three year course of study for various modern avocations in hich scientific knowledge is indispensable, or to lay a liberal and ystematic foundation for higher scientific pursuits. Special and ppropriatie schemes of study are arranged for those who desire) become Chemists, Metallurgists, Civil Engineers, Mechanical ngineers, Miners, Agriculturists, Manufacturers, and for those ho design to pursue the study of Medicine in the Medical Schools. or admission to the first year of this course, the students must ass a thorough examination in Davies's Bourdon's Algebra as far) the General Theory of Equations, or its equivalent; in Geometry, the nine Books of Davies's Legendre, or their equivalent; nd in Plane Trigonometry, Analytical Trigonometry inclusive; nd also in Arithmetic, including the Metrical System, Geography, nited States History and English Grammar, including Spelling. n acquaintance with the Latin Language is also required, sufficient to read and construe some Classical author. Practice in rawing, if it can be obtained before entrance, will be of great dvantage to the scholar.

3. *Special students*—Persons who desire to pursue for a short me a particular branch of science, as Chemistry, Assaying, Mineralogy, Botany, Zoölogy, Practical Astronomy, etc., are also reeived by making personal arrangements with the Professors whose struction they desire.

THE NEXT ACADEMIC YEAR.

The next year of instruction begins Wednesday, September 14, 870. Examinations for admission the same day. The vacations *rrespond with those of Yale* College academical department.

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SIXTH

ANNUAL REPORT

OF THE

HEFFIELD SCIENTIFIC SCHOOL

OF

YALE COLLEGE:

1870–71.

NEW HAVEN:
PRINTED BY TUTTLE, MOREHOUSE AND TAYLOR.
1871.

State Board of Visitors:

CONSTITUTING, WITH THE SECRETARY OF THE SCHOOL, THE BOARD FOR THE APPOINTMENT OF STATE STUDENTS.

May 1870 to May 1871.

GOVERNOR,

His Exc. JAMES E. ENGLISH, New Haven.

LIEUTENANT GOVERNOR,

His Honor JULIUS HOTCHKISS, Middletown.

STATE SENATORS,

Hon. ELISHA JOHNSON, Hartford.
Hon. LUCIEN W. SPERRY, New Haven.
Hon. ELIAB A. CONVERSE, Middletown.

SECRETARY OF THE STATE BOARD OF EDUCATION,

Rev. BIRDSEY G. NORTHROP, New Haven.

May 1871 to May 1872.

GOVERNOR,

His Exc. MARSHALL JEWELL, Hartford.

LIEUTENANT GOVERNOR,

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Rev. BIRDSEY G. NORTHROP, New Haven.

SECRETARY OF THE SHEFFIELD SCIENTIFIC SCHOOL,

Prof. DANIEL C. GILMAN, New Haven.

REPORT OF THE STATE BOARD OF VISITORS.

o the General Assembly of the State of Connecticut:

THE undersigned, in behalf of the State Board of Visitors
the Sheffield Scientific School, respectfully report that the
oard have as usual held two meetings in New Haven, at one
which the appointments of State students were made, and
the other careful examinations and inquiries were made in
spect to the progress of the institution.

The Annual Statements of the instructors are submitted
rewith, as containing full information in regard to the ad-
ncement which has been made during the last twelve months.
y the liberality of a few individuals the school has been able
maintain its rank and to increase its corps of instructors,
it it is still far from having an endowment adequate to the
quirements of the State and country.

The most noteworthy gain during the year has been in a
rection which is closely related to the manufacturing indus-
ies of the State. The appointment of a gentleman who is
th a man of science and a manufacturer to be the professor
mechanic or dynamic engineering has been the occasion for
panding the instruction in that department of applied science.
By several generous gifts large accessions have been made to
e books, models, diagrams, apparatus, and working plans
ustrative of the science of mechanics, and a large hall has
en fitted up for instruction in this department.

The progress of the school in other respects has been good.
he number of scholars enrolled on the annual catalogue was
ne hundred and twenty-three. The State scholarships have
l been taken up, and some of the most promising students
e included among those who receive this aid.

JAMES E. ENGLISH,
Chairman of the State Board of Visitors.

IRDSEY G. NORTHROP,
Secretary of the State Board of Education.

NEW HAVEN, MARCH 13, 1871.

OFFICERS.

CORPORATION.

THE PRESIDENT AND FELLOWS OF YALE COLLEGE.

STATE BOARD OF VISITORS.

THE GOVERNOR, LIEUT.-GOVERNOR, THREE SENIOR SENATORS, AND SECRETARY OF THE BOARD OF EDUCATION.

COUNCILLORS.

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Instructors.

WILLIAM A. NORTON,
Civil Engineering and Mathematics.

WILLIAM D. WHITNEY,
Linguistics and German.

SAMUEL W. JOHNSON,
Agricultural and Analytical Chemistry.

WILLIAM H. BREWER,
Agriculture.

DANIEL C. EATON,
Botany.

EUGENE C. DELFOSSE,
French.

LOUIS BAIL,
Drawing.

OSCAR D. ALLEN,
Metallurgy and Assaying.

DANIEL H. WELLS,
Analytical and Descriptive Geometry.

SIDNEY I. SMITH,
Zoology.

JOSEPH S. ADAM,
Determinative Mineralogy.

CHESTER S. LYMAN,
Physics and Astronomy.

WILLIAM P. TROWBRIDGE,
Dynamical or Mechanical Engineering.

GEORGE J. BRUSH,
Metallurgy and Mineralogy.

DANIEL C. GILMAN,
Physical Geography and History.

OTHNIEL C. MARSH,
Palæontology.

ADDISON E. VERRILL,
Zoology and Geology.

MARK BAILEY,
Elocution.

THOMAS R. LOUNSBURY,
English.

WILLIAM G. MIXTER,
Elementary Chemistry.

ALBERT B. HILL,
Surveying and Mechanics.

CHARLES S. HASTINGS,
Assistant in Physics.

ANNUAL STATEMENT

OF THE GOVERNING BOARD.

In presenting their Sixth Annual Statement in respect to the progress of the Sheffield Scientific School of Yale College, the Governing Board refer with pleasure to the fact that the liberality of many individuals in New Haven and New York has so far enlarged the income of the school as to render possible many desirable improvements. About one half the sum which it was proposed to raise for the immediate endowment of this institution has already been secured, and thus far but one new addition to the capital has been made from persons resident elsewhere than in the cities just named. We have reason to hope and believe that before long other gentlemen, recognizing the importance of such a school as this, and understanding the spirit with which it is carried on, will render substantial assistance in making it more complete and more serviceable in the education of young men.

A special statement of the progress of the subscription will be printed in another place. Here it may be sufficient to say that a considerable part of the increased income has been directed to the enlargement of "the teaching force," that is to say, of the number of instructors, and of the time which some of those heretofore employed devote to their classes. Two of the professors who were on partial salary have been placed on full salary, a new professor has been appointed, and the number of permanent assistants has been increased.

For all the friendly contributions which have been received and for all the good words which have been spoken in respect to the Sheffield Scientific School, the Governing Board are constantly grateful.

1. Expansion of the Instruction in Engineering.

The most noteworthy result of this recent movement has been the enlargement of the department of Mechanical Engineering, which was established in the Sheffield School some years ago.

Prof. William P. Trowbridge, a graduate of West Point, an officer of the U. S. Engineers and of the U. S. Coast Survey, and recently the manager of the Novelty Iron Works in New York City, entered upon the duties of his post as Professor of Dynamic Engineering at the beginning of the present year of instruction. By the kindness of Prof. John F. Weir and the authorities of the Yale School of the Fine Arts, a large hall in the basement of the Art-building erected for Yale College by the late Mr. A. R. Street has been placed for the time being at the service of the Scientific School, and has been conveniently fitted up for Mr. Trowbridge's instruction.

The hall serves the double purpose of a class-room and a cabinet illustrative of the science and art of mechanics. Here are now arranged the various models, diagrams, patterns and pieces of mechanism which constitute the cabinet founded in memory of the late Thomas Fassitt Collier of St. Louis,—a considerable part of them having been bought in Europe by Prof. C. S. Lyman. Here also have been brought together and conveniently arranged the extraordinary collection of Working Plans and Drawings, mentioned in our last year's report as the gift of the Novelty Iron Works in the city of New York, received through the kindness of Howard Potter, Esq. Other gifts of models and apparatus are also arranged in this hall, serving as constant aids to the instructor and incitements to the scholar.

Heretofore in our Annual Statements special prominence has been given to one important matter in addition to the necessary current report of progress. In view of the circumstances just stated, the Board invite attention at this time to the following views which are presented by Prof. W. P. Trowbridge in respect to instruction in Dynamic Engineering, and in respect to the Surveys of large Cities and Towns.

A.—Science of Dynamic Engineering.

The science of Engineering and the professional practices connected with it have of late years undergone a progressive development, the basis of which has been the use of machinery, in all its various forms, for commercial, industrial and domestic purposes.

hrough this agency modern enterprises have been vastly multi-lied, and private corporations have everywhere assumed propor-ions as regards capital and numbers of men employed which a ew years ago would have existed only under the patronage of overnments. There has thus arisen a demand for professional ngineers in a new field distinct from that so long occupied by ivil engineers. And as early as 1863 the Governing Board of the heffield Scientific School instituted a separate course of instruction n this new direction.

There are many reasons or considerations which render it neces-ary and advisable thus to provide two courses in Engineering, ne to embrace the line of studies and applications which belong o Civil Engineering, and the other those which belong to the nore modern science or profession of Dynamic Engineering.

These reasons are chiefly that professional practice and occupa-ion in these two branches of the subject, respectively, are entirely lifferent one from the other, and involve different elements of nowledge in the sciences and in the practical arts.

In Civil Engineering the practice of the profession is confined o the erection of permanent structures. No elements of power, notion, or work are involved, except as mere temporary auxiliary ids, while Dynamic Engineering is based exclusively on the con-inuous and perpetual applications of motion and force in accom-plishing useful work.

The *elementary* studies in this new course differ very little from hose in the Civil Engineering course, but there is a constant di-ergence as the student advances. The practice of the art of in-trumental drawing becomes more complex and difficult in its applications to machinery; the applications of mathematics more extended, requiring more exact and definite knowledge of princi-ples and rules, on account of their more frequent recurrence in every-day practice; and it is found essential to introduce more thorough instruction in the sciences of applied mechanics, chem-istry, and physics.

In Civil Engineering the application of the science of mechanics is confined substantially to the simple problems of statics, while in Dynamic Engineering this branch of mechanics has a secondary importance to that which treats of the more complex and difficult laws which govern the relations of force and motion combined.

Relations of Theory and Practice.

In both branches of Engineering, as indeed in all departments of instruction in the applied sciences, it has become apparent, in view of the great extent of ground to be gone over and the multiplicity of applications of the same general laws, that a more comprehensive view of the methods of instruction must be taken. It has become of vital importance that the mere comprehending of principles and laws as they are enunciated or demonstrated, and the mere accumulation of facts or truths, shall not be regarded as the limit and aim of instruction. But the student is to be taught, while pursuing any course of study or the investigation of any special subject, under what circumstances and in what manner the knowledge he is acquiring is to be made useful, through the exercise of his own intelligence. This involves, first, impressing on the mind by every possible means such a knowledge of the fundamental principles of every subject taught that they shall be retained in the memory; and second, the bearing or use of those principles, in the processes of investigation or reasoning, which belong to the profession to which they are applicable.

The practice of instrumental drawing should comprehend not only the learning of an art, useful in every sphere of life; as an aid to the memory and to fix the conceptions of the mind; but the course of instruction should embrace the actual delineation of various kinds of structures and machines of the most approved character. It should also comprise the designing of such structures for various purposes when the student shall have acquired the knowledge of the principles of mathematical and mechanical science necessary for the solution of special problems corresponding to those which are to be encountered in practice.

Thus while the art of drawing cultivates the use of the hand, the eye, the exercise of the memory, and the imaginative powers of the mind, it becomes a means of fixing the perceptions, of expressing the thoughts, and of the solution of mathematical problems, always at command, and assists rather than obstructs the higher exercise of the powers of the intellect.

The abstract science of mathematics is to be regarded from the same point of view. The highest view which can be taken of this study, regarded merely as a disciplinary study, is that which points out its uses. Unconnected with its useful applications in explaining or describing natural phenomena and laws, or solving *problems* relating to the properties of matter or the relations of

lines and surfaces, of motion and force, its full significance is not brought out.

The chief value of this science consists in its giving results through the mere mechanical use of signs and symbols which the mind could not otherwise deduce, and the facility or readiness with which it may be employed by any person determines to him its greatest value.

The same may be said of the science of mechanics, of physics, of chemistry, and of metallurgy. In all these branches of natural and applied science, while a knowledge of facts, of laws and of phenomena is acquired, there still remains the higher and more important kind of knowedge to be imparted, viz.: a clear and distinct separation of the fundamental principles and laws from the secondary and unimportant, though vastly more numerous, phenomena connected with their application or occurrence; and it should be a prominent part of instruction to point out to students the proper uses of the various branches of knowledge which they may acquire, in order that they may be taught to be self-reliant, dependent only on truths, facts, and laws; but not upon precedents nor even rules, unless such precedents or rules are clearly in accordance with fundamental principles.

The demand in this country for Dynamic Engineers.

The course in Dynamic Engineering is intended to meet in this respect a want long felt in this country. It embraces the applications of the science of heat as a motive power, comprising the modes of generating and utilizing steam, the constructing of the special forms of steam machinery applicable to ships, railroad transportation, mines, furnaces, mills, &c. It embraces also the utilization of water-power, comprising the theoretical principles which govern the use of this natural source of energy, and the construction of the machinery and apparatus by which such use is accomplished. It includes the detailed plans for the erection of mills and manufactories, the construction of tools, the preparation of materials in forges and rolling mills.

All these branches of commercial and industrial enterprise form fields of employment, for which it has become the duty of special institutions of learning to provide by supplying the facilities for instruction and learning necessary for those who may wish to choose these fields of usefulness for their spheres of labor and occupation.

The question is frequently asked by students and applicants for admission to the Sheffield Scientific School, what opportunities for occupation or employment are open to graduates in the course of Dynamic Engineering? This question cannot be answered specifically in any other manner than by referring to the vast number of industrial establishments throughout the country devoted to manufactures of all kinds, including raw materials, tools, machinery, fabrics, and implements or articles needed for domestic economy; in all of which persons of superior training are required. But a more general and perhaps more satisfactory answer to the inquiry may be given.

Those who follow the profession of Dynamic Engineer are more or less connected with the active business operations of the country, having opportunities of becoming identified with special interests and of obtaining fixed and permanent positions. There is thus always before a young man in this profession the prospect of personal independence.

On the other hand, as a strictly professional occupation, those who wish to become consulting engineers find a wide range of subjects on which their skill and judgment are consulted, especially in private and individual enterprises, which are even more varied and numerous than public undertakings. In this respect the profession of Dynamic Engineering corresponds more closely with that of Architecture, in which the chief source of employment arises from the demands of private individuals or corporations.

While prominence is thus given to the subject of Dynamic Engineering, attention is likewise especially called to the course in Civil Engineering in a manner about to be stated with reference to the improvements of towns and cities.

The newer branches of the profession, as well as the familiar departments, call for large numbers of young men; and the day is not distant when every compact city or town having more than ten thousand inhabitants will require the constant advice and service of a competent city engineer. The grading and laying out of streets, the construction of water-works, and of sewerage and drainage systems, the establishment of parks and promenades, the building of substantial wharves and piers, the removal of whatever is prejudicial to the public health, and other kindred occupations, are likely to call for a much greater number of competent advisers than this or any institution can furnish for many years to come.

In this connection it is well to add that the mathematical studies of the engineering course, in connection with the study of building materials and cements, under the guidance of the professors of mineralogy and chemistry, are a good basis for the profession of the Architect. Much study in the specialities of that profession will of course be required, but many of the preliminary essentials may be gathered in this school of science as already organized.

With reference to the improvements of cities, a true or orthographic map of the surface of the land is now an important requisite. The following paper discusses the preparation of such a map.

B.—Orthographic Surveys of Cities.

The application of the principles of Geodetic and Plane-table Surveying to the surveys of cities has recently been thoroughly developed by the United States Coast Survey in the survey of the city of Portland, Maine, and in some other instances, and the advantages of the system thus worked out, over the customary but radically defective methods so long in use in this country, have become so apparent, that the Governing Board of the Sheffield Scientific School are about to take measures to introduce a course of instruction having for its object the training of young men in the practice as well as the theory of this system.

To accomplish this end it will be essential to give students a large amount of practice with the plane-table, combined with the theodolite and level, in the field; and through the kindness of Prof. Peirce, Superintendent of the Coast Survey, advantage will be taken of the presence of the party of Mr. R. M. Bache (United States Coast Survey) in this vicinity during the coming season, to initiate several of our graduates in the use of the instruments and in the methods employed, in order that they may become instructors to others; so that in a very short time it is hoped that graduates of the School may be fully qualified for conducting City Surveys by the more accurate processes which the practice of the Coast Survey has given to the country.

The rapid growth of the cities of this country is a matter of universal observation and comment, and everyone who has lived for a long time in one of these growing towns is familiar with the manner of their expansion. It is seldom that the first founders of a small town have sufficient faith or foresight in regard to the future extensions of their municipal jurisdiction to enable them to lay

out definite plans for such extensions, except perhaps the mere drawing on paper of what may become the lines of future streets. From time to time new areas are taken into the city limits; the streets already in existence are extended or new ones projected; and new districts, which before had been occupied as farm lands, become thickly populated. Where the land was at one time the property of a single individual and was bought and sold by the acre, and estimated at a certain number of acres, more or less, it becomes divided among hundreds and perhaps thousands of proprietors, and is valued and sold by feet and inches.

Whatever plan may have been adopted for the directions and locations of streets and squares, new questions of the highest importance constantly arise in regard to grades of streets, the locations of sewers, and the provisions for drainage; questions not of convenience, merely, to the population, but of vital importance to the health of the inhabitants. One set of men plan one portion of the city; and years afterwards, when they are dead and gone, and their ideas forgotten, another set of men plan another district; the old drains or sewers are found to be too small, or not located to meet the necessities of the new improvements; streets must be again dug up for new sewers, and old grades altered to conform to the new, and possibly the natural lines of drainage for the new localities have been completely blocked up by foundation walls of buildings; and there is no resource but to allow the water that falls upon the surface to remain stagnant in a water-soaked stratum beneath the surface. There having been no unity of design in anticipation of so great an expansion, the evils which follow, however great they may be as regards health and comfort, must often be suffered to exist on account of the great expense which would attend any reasonable attempt to remedy them.

But these evils, defective drainage and its fearful consequences, the alteration of grades, and the necessity for building enlarged sewers, involving perpetual assessments, are not the only evils which are entailed on successive generations. Few people are aware of the fact that the process by which streets are laid out and the land ultimately divided up among its thousands of owners is radically defective. We do not refer to surveys by the magnetic compass: that instrument has long since been banished from the list of surveying instruments, where any attempt at accuracy is made; but to the approved processes which are employed by the best city surveyors at the present day.

The defects do not lie in the instruments which are employed, the theodolite, transit, spirit-level, and chain or steel tape-line: nor in a want of skill in the surveyors; but in the system which is followed in making use of these valuable instruments. The transit is an instrument designed to enable a surveyor "to run a straight line," to use a well understood form of expression; that is to say, to enable a surveyor to trace out a line on the surface of the earth which shall lie in one vertical plane; or to trace the line in which a vertical plane intersects the earth's surface. For this purpose it is the best and perhaps the only reliable instrument. The spirit level is employed to determine the relative altitudes of the points of such a line, or of any two or more points above a fixed plane or point which is chosen as a reference. But neither of these instruments furnishes the means or facilities for measuring horizontal distances; and the relative horizontal positions of lines and points must be determined by some other process. Here lie the defects of the system. The very measurements which, of all others, are to constitute the map, and by which the relative positions of lines and points estimated in horizontal directions are to be determined, the measurements and distances which are to determine proprietary lines, where the ground may be valued at hundreds of dollars per square foot, are left to the deceptive and false determinations which result from chain or tape-line measurements along undulating surfaces. The true idea of a map of a city is that it is a projection upon a horizontal plane of the boundaries and division lines of the site. But no city map fulfills this condition that is constructed by the methods of surveying at present in use. No means are taken to reduce the measurements to horizontal projections, except perhaps in rare instances where the declivities are very great, and even in such cases the partial and inaccurate reductions only add to the general confusion. It has been supposed doubtless that the errors arising from the tape-line or chain measurements along undulating surfaces are unimportant; and yet there is probably not a city survey in this land in which continued adjustments of property lines have not been found necessary. One city surveyor lays out property on streets which are not graded, and his successor in attempting to reproduce the former dimensions and distances after the grades have been established and the embankments and fillings executed, finds that these dimensions and measurements will not fit the ground, and with denunciations of the errors of his predecessors, he proceeds to make adjustments.

The owner of a house finds that his wall stands several inches upon his neighbor's ground, or that he does not own "down to the center of the earth and up to the sky" of quite as much area as he thought he did, and litigation is resorted to, to settle the difficulty.

The true cause of all these difficulties may be easily explained. Let us suppose that the site of a town or city projected upon a horizontal plane is a true square, but that the surface of the ground is undulating. To begin with the exterior boundaries: these are usually run from one fixed land-mark to another; in the case under consideration these landmarks may be the four corners of the square.

The surveyor proceeds to run straight lines with his transit and to measure the lengths of the sides with his chain. The ground being undulating the lengths measured along the surface are greater than their true horizontal projections, and the four sides, as measured, will all be greater than the true boundaries, and all different from the others; and the map drawn from such a survey will not appear as a square, as it should, but as an irregular polygon of four sides. So with lines running across the site; wherever a measurement is made upon an inclined surface, that measurement will be too great, if used without correction, and the result will be a general and irregular distortion. Lines which are first laid out on paper and then transferred to the ground, will show gores and overlappings, attributable to unavoidable errors of the survey; and the remedy adopted is to make the best adjustment possible under the circumstances. Succeeding surveyors find no base lines or standard distances to measure from, because every change in the surface produces changes in the measurements between established points.

Since the true theory of a city map is, and should be, that it is a horizontal projection of the lines of streets and of division and boundary lines, it is evident that such a map, if enlarged to the scale of the natural lines of the city and spread over the city, should be so accurate that each line and point of the map would fall upon its original in nature. Such a map it is impossible to make by the present methods, whatever may be the skill of the surveyor or the perfection of the instruments; and the errors introduced by these methods have been the fruitful source of litigations, heavy expenditures in the alteration of lines of streets and buildings, and of general uncertainty and inconvenience.

Use of the Plane-table.

The true remedy for all the difficulties of drainage, sewerage-grades, the want of fixed lines of division, and of correct boundaries, may be found in the use of the PLANE-TABLE.

This instrument has long been known, and is described briefly in all good works on Surveying; but though simple in its design, there is no instrument which requires so much practice in its use in order to bring out and employ its valuable qualities.

To survey a city with this instrument a single line is first measured by an apparatus which gives the true horizontal length of the line with great precision. With this line as a basis a series of triangles is established covering the whole site, the angles of the triangulation being measured with the theodolite and the length of the lines calculated trigonometrically. There are thus established a number of fixed points, the distances of which from each other depend in no measure upon the configuration of the surface, but these points are the true horizontal projections of such points on a plane of reference, which plane is represented by the map. The plane-table is then employed to continue this triangulation by dividing up the large triangles, even to the most minute distances; every topographical feature of the site being determined by the intersection of geometrical lines upon a horizontal plane: division lines, the lines of buildings, lines of streets, and all other features, are thus determined, and the connecting lines between them drawn in on the ground; so that the map of the city is made not in the office, but in the field, and presents when completed, not the distorted results of surface measurements, but the true projections of the lines and points of the surface without regard to elevations and depressions.

In connection with this system of geometrical and orthographic surveying the spirit-level is employed in combination with the plane-table to determine the altitudes of all points of the site. For this purpose the lines of intersection of horizontal planes, three and six feet apart, are marked out on the ground by the level, and the curves thus formed are transferred to the map by the plane-table; so that the completed map presents not only the true horizontal projections of the lines of the city, but also the horizontal projections of a system of curved lines which pass through all points at altitudes of 3, 6, 9 and 12 feet respectively above the plane of reference. The map thus constructed is a miniature representation of the surface delineated, not only in horizontal, but in its vertical features.

Value of a true City Map.

With such a map as a basis all the important problems of city engineering become easy of solution. The lines of natural drainage and the planes of the water-sheds become apparent on a simple inspection; and thus the course as well as the magnitudes of the drains and sewers may be indicated with unerring certainty. The establishment of the grades of the main avenues and cross streets may be adjusted in such a manner as to avoid unnecessary expense in cutting and filling; and with reference also to the all-important system of drains and sewers.

The study of such a map will enable an engineer to point out those areas which should not be built upon until they are raised by filling to the proper level; and private improvements are thus rendered secure from subsequent changes or alterations.

The first essential element to successful city engineering thus lies in a thorough orthographic survey, without which all engineering operations must, to a greater or less extent, be imperfect in design, because they are not based upon the true topographic features of the site to which they are applied.

Among all the great benefits which the United States Coast Survey has conferred on this country, the development of this true system of city surveying is among the most important; every city in the land should avail itself of this method at the earliest possible moment, in order to avoid the perpetual propagation of the evils and defects of the existing surveys. In the case of the city of Portland, as it will be for all the Atlantic coast cities, the primary and secondary work of triangulation of the coast already made by the Coast Survey, furnishes a ready basis for city maps by the plane-table. For cities thus situated the revision of their maps will be comparatively simple and inexpensive.

The only difficulty that still presents itself is a deficiency of men who are expert in the use of the plane-table, which is still a new instrument to general practice. To supply this want as far as practicable, the Sheffield Scientific School of Yale College contemplates establishing the course of instruction to which reference has been made.

2. Expansion of the Instruction in the English Language.

During the past two years the instruction in the department of English has been extended so as to embrace many subjects, which *have* not as yet been included even in the course of most classical

schools. As this, however, has hitherto been deemed in some respects an experiment, it has not been thought best to make to it, in our previous reports, anything more than a brief allusion. The success which the experiment has met with in supplying a want which has long been felt, and which will doubtless continue to be more and more felt, has been decided enough to warrant the retention in all its essential features, of the course already pursued, necessarily making such changes as may be demanded by the wants of those seeking instruction, or such as additional experience may show to be desirable.

The course in English includes both the study of the language and of the literature. In respect to the former, so much of Anglo-Saxon and early English is taught as to enable the student to gain a clear and connected knowledge of the origin and history of the language, of the successive changes it has undergone, and of the rise and development of the grammatical forms, idioms and leading characteristics of modern English. The purely grammatical and linguistic study is confined mainly to the writers of the Anglo-Saxon and early English period, it being deemed desirable in the case of the great classic authors of our tongue to entirely subordinate philological to literary culture, the latter being made specially prominent, the former is pursued with them so far only as it contributes to the comprehension of the writer's meaning, and of the changes that have gradually taken place in the history of our speech. Sufficient, however, of linguistic study, is required to enable the student to read any early English author with facility: for those who wish to carry this course further other arrangements will be made.

The study of the literature consists mainly in the study of the works of English authors themselves. For obvious reasons the greatest authors are selected. In the course as now constituted, students read Chaucer, Spenser, Bacon, Shakespeare, Milton, Dryden, and Pope. When the term of study is extended to four years, it is hoped to bring the work down so as to include the writers of our own times; but under present circumstances it has been deemed best to confine the attention of students to the more prominent older authors of our tongue, who, though much talked about, are generally very little read.

For the purpose of combining, as far as possible, the study of the language with that of the literature, it is an essential part of this plan that writers should be taken up in chronological order. It is likewise essential to the literary culture sought to be imparted

that either a whole work of an author should be studied, or a part forming by itself a complete whole. This system has now been pursued here long enough to warrant us in expressing our satisfaction with its results. Having outlived the period of experiment it will hereafter be included as a regular part of the course.

In connection with this study practice in essay-writing will be a subject of special attention, subjects being drawn as far as possible from the literary history of the period whose representative author is in the act of being studied.

In the English Language Mr. Thomas R. Lounsbury has been during the last year and a half the instructor.

The study of the general principles of Linguistic Science is carried on as heretofore under the instruction of Prof. Whitney.

3. Expansion of the Study of Drawing.

In future it is the intention of the Governing Board that every student shall devote more time to Drawing than has heretofore been allowed. During the past year a committee of the instructors has been in conference with Professor Weir of the Yale School of the Fine Arts, in reference to the best mode of securing for the Sheffield students a greater amount of practice, and also in regard to the principles and method which should govern this practice. A full report on this subject may be expected at a future time.

Already the students in the Scientific School have begun to receive instruction in elementary drawing in the rooms of the Art School, and have had the advantage of seeing and studying the casts, diagrams, models, and works of art which are rapidly accumulating in that department of Yale College.

It is expected that hereafter the Freshmen will spend a considerable amount of time in elementary drawing, in order that the eye may be trained to accurate observation and the hand to exact delineation of any simple object. As the classes divide into their special sections during the later years of the course, some of the students, especially those in the engineering studies, will naturally concentrate their attention upon instrumentral drawing of various sorts; while others, especially the students devoted to natural history, and those of the select course, will continue to be practised in free hand drawing.

Important discipline of some of the faculties of the mind will be secured by this course of instruction; and it is hoped that not *a few will* become expert in the art of expressing with the pencil *that which* they have seen or devised.

4. Public Lectures.

The sixth annual course of Lectures to mechanics and others has been given during the past year. The lecturers and their subjects are indicated in the annexed programme.

PROGRAMME.

1.	Monday, Feb. 6.	Placer Mining in California,	W. H. Brewer.
2.	Thursday, " 9.	Sound,	C. S. Lyman.
3.	Monday, " 13.	Spots on the Sun,	A. W. Wright.
4.	Thursday, " 16.	Original Investigations on Economy in the use of Steam in Steam Engines,	C. E. Emery.
5.	Monday, " 20.	Surveying in the Western Mountains,	J. T. Gardner.
6.	Thursday, " 23.	The Coal-Tar Dyes,	S. W. Johnson.
7.	Monday, " 27.	Work and Wealth,	B. G. Northrop.
8.	Thurs., March 2.	Polarization of Light,	G. F. Barker.
9.	Monday, " 6.	Metamorphosis in Animals,	S. I. Smith.
10.	Thursday, " 9.	Deep-Sea Soundings,	W. P. Trowbridge.
11.	Monday, " 13.	Deep-Sea Life,	A. E. Verrill.
12.	Thursday, " 16.	English Orthography,	T. R. Lounsbury.
13.	Monday, " 20.	Theory of Combustion,	W. G. Mixter.
14.	Thursday, " 23.	Aluminum,	G. J. Brush.
15.	Monday, " 27.	Connecticut in the light of the New Census,	D. C. Gilman.

Five of the lecturers above named, Prof. Wright, Mr. Emery, Secretary Northrop, Mr. Gardner and Dr. Barker, are not instructors in the School, and special acknowledgements are due to them for their coöperation.

By invitation of some of the friends of the School in Hartford, and of the officers of the Young Men's Institute in that city, several of these lectures were repeated in Allyn Hall, as follows:—

1.	On the Rocky Mountains,	W. H. Brewer.
2.	" Deep-Sea Soundings,	W. P. Trowbridge.
3.	" Sound,	C. S. Lyman.
4.	" English Orthography,	T. R. Lounsbury.
5.	" Metamorphosis in Animals,	S. I. Smith.
6.	" Deep-Sea Life,	A. E. Verrill.
7.	" Weeds,	D. C. Eaton.
8.	" Connecticut in the Light of the New Census,	D. C. Gilman.

For the purpose of bringing the aims of the School before leading men in different parts of the State, meetings were held, sometimes in public halls and sometimes in private parlors, during October last, in several of the towns of the State.

To the various gentlemen by whose kindness the arrangements for these meetings were perfected, and to those whose hospitality the speakers received, the thanks of the School are particularly due.

The places thus visited were New Britain, Norwich, Woodstock, Danielsonville, Birmingham, Litchfield, Waterbury, Bridgeport, Stamford, Norwalk, Danbury and Meriden. Similar meetings were also held in New Haven, as in the previous winter they were in Hartford.

On the seventh of October, Prof. Trowbridge delivered in Sheffield Hall his Inaugural Address on the Profession of the Dynamic Engineer. It was published at the expense of one of the benefactors of the School, and a second edition was printed and circulated by Henry Carey Baird, Esq., of Philadelphia.

5. Anniversary and Prizes.

The Anniversary of the School was held on Monday, July 18th, when the following themes were discussed by the candidates for degrees. Those persons whose names are prefixed with a star read their discourses in the evening; the others were presented in the morning.

GRADUATES OF 1870,

WITH THE SUBJECTS OF THEIR GRADUATING THESES.

DOCTOR OF PHILOSOPHY.

Nelson Powell Hulst, A.B., Ph.B., *New Haven.* A Chemical Examination of the "Malleable Iron Process."

CIVIL ENGINEERS.

Augustus Jay DuBois, Ph.B., *New Haven.* Design of a Parabolic Truss Railway Bridge.

Albert Banks Hill, Ph.B., *Redding.* Design of a Steel Railway Bridge.

BACHELORS OF PHILOSOPHY.

*James Whitin Abbott, A.B. (Engineering), *Yarmouth, Me.* "On a Two-feet guage Railway in Wales."

Henry Moore Bailey, (Select), *Rutland, Vt.* "On the Marble Quarries of the Neighborhood of Rutland."

Charles Thruston Ballard, (Select), *Louisville, Ky.* "On Sheep Raising in the United States."

Thomas Gray Bennett, (Engineering), *New Haven.* "On the Works of the Fair Haven Water Company."

Townsend Stith Brandegee, (Engineering), *Berlin,* "On the Hoosac Tunnel."

*Daniel Seymour Brinsmade, (Engineering), *Trumbull.* "On the Water Power at Birmingham, Conn.

*Charles Peter Brooks, (Engineering), *Blooming Cove, N. Y.* "On the Elevated Railroad in New York."

HOMAS ELWOOD CALVERT, (Engineering), *Newtown, Penn.* "On the Pneumatic Underground Railway in New York."

FREDERIC HOSEA CHURCHILL. (Select), *New Britain.* "On Technical Education in its relation to American Manufactures."

ORR CLARKE, (Engineering), *Batavia, N. Y.* "On Leffel's Double Turbine."

LFRED RONALD CONKLING, (Mining), *New York City.* "On the new Barytes Mines in Cheshire, Conn."

JUSTUS HERBERT GRANT, (Engineering), *Auburn, N. Y.* "On Permanent Way."

CHARLES SHELDON HASTINGS, (Engineering), *Hartford.* "On the Properties of Réseaux."

WILLIAM ALFRED HINDS, (Select), *Wallingford.* "On the Recurrence of Civilizing Forces."

DWARD VAN BUREN HOBS, (Select), *Ottawa, Ill.* "On Trade Unions."

VILLIAM RUFUS HOPSON, (Select), *Bridgeport.* "On the Vegetable Kingdom in its Relation to Man."

[ENRY CORBELL HUMPHREY, (Chemistry), *Stamford.* "On Cumarin and Cumaric Acid."

'RANCIS ASBURY LOWE, (Engineering), *Washington, D. C.* "On the Geared-screw type of Marine Engine."

WILLIAM DENNIS MARKS, (Engineering), *St. Louis, Mo.* "On the Best Form of a Ship for Speed," with an original example.

ARTHUR WOODS RICE, (Engineering), *West Meriden.* "On a Preliminary Survey of a Branch Railway."

'EORGE DOUGLASS ROSEBERRY, (Chemistry), *Pottsville, Pa.* "On Anthracite Coal and Coal Mining."

LFRED STANTON, (Engineering), *Sligo, Md.* "On the Desirability of Irrigation in this Country."

LARENCE AUGUSTUS WARREN, (Engineering), *Louisville, Ky.* "On Railway Rails."

JOHN GEORGE WATSON, (Engineering), *Ayr, Canada.* "On an Improved Mowing and Reaping Machine."

THE FOLLOWING PRIZES WERE AWARDED AT THE ANNIVERSARY:

1. *For excellence in the Engineering Studies of the Senior Year.*

   A prize of $20.00, divided between JUSTUS H. GRANT of *Auburn, N. Y.*, and ARTHUR W. RICE of *West Meriden;* with honorable mention of CHARLES S. HASTINGS of *Hartford.*

2. *For excellence in Chemistry.*

   A prize of $20.00, to HENRY C. HUMPHREY of *Stamford.*

3. *For excellence in Mineralogy.*

   A prize of $20.00, to BERNARD J. HARRINGTON, B.A., McGill University, *Montreal.*

4. *For the best English Essay.*

A prize of $20.00, to WILLIAM A. HINDS of *Wallingford*, for "an Essay on the Physical Structure of England in relation to her History."

5. *For excellence in French.*

A prize of $10.00 to JOHN G. WATSON of *Ayr, Canada.*

6. *For excellence in German.*

A prize of $10.00, to TOWNSEND STITH BRANDEGEE of *Berlin.*

7. *For excellence in Mathematics of the Junior Year.*

A prize of $20.00, to CHARLES W. GRISWOLD of *New Britain.*

8. *For excellence in the Freshman studies.*

A prize of $20.00, to DANIEL W. HERING of *Johnsville, Md.;* with honorable mention of J. J. ABBOTT of *Yarmouth, Me.*, Second in Rank.

At the examination for admission to the Freshman Class in the autumn of 1870, the prize for excellence was awarded to Edward J. Hall, of Buffalo, N. Y.

On Wednesday afternoon, July 20th, a Public Address was delivered in the First Methodist Church by Rev. Dr. HORACE BUSHNELL of Hartford, on the New Education in Science. The past and present members of the State Board of Visitors, Councillors of the School, together with the graduates and undergraduates, met at Sheffield Hall, and went together in a procession to the church. The discourse was listened to with marked attention and interest, and was subsequently printed in *Hours at Home*, for September.

6. GIFTS TO THE PEABODY MUSEUM OF NATURAL HISTORY.

The collections in Mineralogy, Geology and Zoology, which are soon to constitute the Peabody Museum of Natural History, have continued to grow during the year that is past. Although these collections are the property of Yale College, in its most comprehensive sense, they are of so much advantage to the higher interests of science as to require recognition in this report of the School. The usual lists of additions in zoölogy and geology will be printed elsewhere, but special attention is here invited to the following very noteworthy accessions:

1. *Zoölogical Department.*

PROF. A. E. VERRILL, CURATOR.

During the year many valuable additions have been made to the Zoölogical collections. Among the more important gifts are two large collections of the marine shells, corals, echinoderms, etc., of the Gulf of California, sent by Capt. J. Pedersen, whose death, last autumn, deprived us of a valued friend and coöperator; an excellent collection of the birds of India from Geo. A. Kittredge, Esq.; a collection of birds' eggs from the Smithsonian Institution; a skeleton of the East Indian Tapir, together with other skeletons and skulls, and numerous fresh-water mammals, birds, and reptiles, intended for the preparation of skeletons, from Professor O. C. Marsh; a number of valuable skulls and skeletons from the Rocky Mountains and California Coast, obtained by the Yale Scientific Expedition, under Professor Marsh; a very large and complete collection of the marine animals of the Bay of Fundy, collected by Professor Verrill and Mr. Oscar Harger, during an expedition to that region in the summer vacation; numerous insects, etc., from Walpole, N. H., and marine animals from Fire Island, L. I., collected by Mr. S. I. Smith during the summer vacation. Other valuable collections have also been received.

Professor Dana has also made a very important gift of books and pamphlets, mostly relating to Crustacea, together with his sea-notes and numerous drawings made while on the United States Exploring Expedition, under Capt. Wilkes. In addition to their intrinsic value, these notes and drawings will be of great interest in connection with the history of Zoölogical science.

The work of cataloguing and labelling the collections has steadily advanced during the year. Mr. S. I. Smith has determined and described many of the Crustacea, Mr. Oscar Harger has identified the American Myriapoda, Mr. Belknap has given much assistance in cataloguing the fresh-water Mollusca, Professor Verrill has completed his works on the Echinoderms and Corals of the west coast of America, which have been published in the Transactions of the Connecticut Academy, and will serve as complete catalogues of our collections in those departments. He has also determined the Ascidians of the New England Coast, and has described the new and imperfectly known species in the American Journal of Science. The exchanges have been extended as rapidly as the very limited amount of time that the curator has been able to devote to it would admit. Several collections have been sent away during the *year and others* are in preparation.

2. *Geological Department.*

PROF. O. C. MARSH, CURATOR.

The past year has largely enriched the collections of the Geological Museum of Yale College, the additions in fossil vertebrates alone exceeding the material previously obtained. Continued progress has also been made in arranging and cataloguing the specimens recently secured; and in this work Mr. Oscar Harger and Mr. Henry S. Williams, assistants in Palæontology, have done good service. Especial efforts have been made, moreover, to increase the collections in recent Osteology, more particularly for use in investigating the many remains of extinct vertebrates now in the Museum.

Among the most important acquisitions made since the last Report are the entire collections of Cretaceous and Tertiary fossils obtained by the Yale College Expedition, in charge of Professor Marsh, during their explorations last summer in the Rocky Mountain region. These collections embrace more than ten thousand specimens, including at least fifty species of extinct Mammals, Birds, Reptiles, and Fishes new to science, with many interesting and undescribed invertebrate remains.

The most noteworthy and valuable single gift to the Museum received during the past year is a large and unique series of fossil Fishes, from the sandstone of the Connecticut valley, and other localities of the same formation, with several other instructive suites of American and European fossils, together constituting the collection of the late William C. Redfield, Esq. This very important addition to the Geological Department, amounting to several thousand specimens, was generously presented by John H. Redfield, Esq., of Philadelphia, and Charles B. Redfield, Esq., of Pittsfield, Mass.

Several interesting collections of Cretaceous fossils have lately been received from the marl region of New Jersey, especially from John G. Meirs, Esq., in behalf of the Cream Ridge Marl Company; from the Pemberton Marl Company, through J. C. Gaskill, Esq.; and from the West Jersey Marl Company, through I. C. Voorhies, Esq., Superintendent. An extensive collection of *Melonites*, from the St. Louis limestone of Missouri, undoubtedly the finest series in the country, has recently been secured for the Museum, from Professor A. Litton, of St. Louis. Many other important additions made during the past year are noticed in the list of donations.

3. *Mineralogical Department.*

PROF. G. J. BRUSH, CURATOR.

The Mineralogical Cabinet of Yale College has been very greatly enriched by the acquisition of the famous collection of pseudomorphs made by Prof. Blum of Heidelberg. This collection is unique. It is the result of thirty-eight years of enthusiastic devotion to the specialty of pseudomorphs by the first authority in this department of Mineralogy. The specimens, numbering over 1700 (exclusive of duplicates), are the original material which furnished Prof. Blum the important facts recorded in his work, *Die Pseudomorphosen des Mineralreichs*, published in 1842, and the subsequent "Nachträge," published in 1847 and 1852. It is conceded to be the most complete collection of pseudomorphs in existence, and its addition to the Mineralogical Cabinet here is of the highest importance to students and investigators in Mineralogy and Geology.

The acquisition of this remarkable collection for the Cabinet is due to the liberality of JOSEPH SAMPSON, Esq., of New York, who on learning the character of the collection and the desirability of obtaining it, most generously gave $3000 to purchase it. This is the largest and most important addition made to the Cabinet since the purchase of the Lederer collection in 1843.

Dr. Wolcott Gibbs of Harvard College, and George Gibbs, Esq., of New York, have generously presented the Cabinet with several hundred specimens of American minerals, in part collected by their father, the late Col. George Gibbs, the former owner of the College Cabinet. This collection contains many valuable additions for the Cabinet from old and now exhausted American localities.

4. *Archæology and Ethnology.*

Among the more noteworthy acquisitions since the last Report, may be mentioned a collection of about seven hundred characteristic stone implements from Southern Ohio; a choice series of three hundred North and South American antiquities, forming the collection of Dr. Joseph Leidy; a suite of one hundred and fifty rare forms of stone implements from New England, collected by R. H. Rust, Esq., of Massachusetts; and a collection of several hundred antiquities from a mound in Missouri, including about fifty specimens of Pottery, some of the finest hitherto discovered in North America. These various antiquities, about fifteen hundred in num-

ber, are the gift of Professor Marsh. Other interesting and valuable additions to the Museum have been received, and are acknowledged in the list of donations.

7. The other Gifts of the Year.

In addition to the money gifts to which allusion has been made, the School has continued to receive a large number of other donations which are highly acceptable and useful.

Drawings of the Novelty Iron Works.

Foremost in importance is the collection of Drawings from the Novelty Iron Works, to which a brief allusion was made last year, and of which a catalogue is now given in the Appendix.

The establishment from which this valuable donation was received has been for about forty years one of the most prominent in this country in the manufacture of machinery. It was originally founded by Dr. Nott, late President of Union College, and had its origin in the efforts he was making to introduce the use of anthracite coal as a fuel for the steam engine. For this purpose Dr. Nott built a small steamboat to run on the East River, which, being novel in design, and novel in regard to the fuel to be used, he named the "Novelty." A small building, standing near what is now the foot of 12th street, East River, was converted into a primitive shop for the purpose of repairing this novel steamboat, and this building received from the workmen the name of the "Novelty's Works." From this the name of the works finally became "The Novelty Iron Works."

The machinery manufactured at these works during its long and useful career comprised all the varieties which the country from time to time demanded; and included stationary engines and boilers, sugar machinery, machinery for mills of all kinds, hydraulic presses, and a great variety of other special machines and tools. The chief direction finally given to the work of the establishment was the construction of marine engines. An inspection of the catalogue will show what a large number of steamship engines of the largest class for vessels, the names of which are familiar to all, were designed and built at these works.

In this field of usefulness the success and reputation achieved was mainly due to the engineering abilities of Mr. Horatio Allen, and the successful business administration of Mr. Howard Potter. The works were closed in 1869 by the voluntary action of the stock-

holders, on account of the falling off of the steamship building business in this country, ocean steamship construction and navigation having passed almost entirely into foreign hands. When the question came up, as to what disposition should be made with the valuable drawings accumulated during this long career, it was decided, through the liberal representations of Mr. Howard Potter, that the proper place for the collection would be in an institution of learning devoted especially to the subjects to which the collection relates; and the Sheffield Scientific School became the grateful recipient.

Illustrated Catalogues of Connecticut Manufactures.

The Library has received a few valuable gifts. Among the most noteworthy are some of the Illustrated Catalogues of manufacturing establishments in Connecticut, which are among the most perfect specimens of typography executed in this country. One of these Catalogues exhibits by engraving and letter press the articles which are made in the line of cutlery and hardware at the Ætna Works of Messrs. Landers, Frary & Clark, in New Britain. A second Catalogue exhibits the various hinges, door knobs, escutcheons, etc., made in a peculiar and beautiful sort of bronze by the establishment of Messrs. Russell, Irwin & Co. in New Britain. A third Catalogue exhibits by engraving the artistic work of the Ornamental Wood Company in Bridgeport.

The last and in some respects the most elaborate of these works presented to our Library is the Illustrated Catalogue of door locks, knobs, and padlocks, manufactured by Messrs. Mallory, Wheeler & Co., a folio work of extraordinary typographical perfection. Like the other Catalogues, it was printed at the office of Messrs. Wm. C. Hutchins & Co. in Hartford.

These Catalogues are valuable not merely as specimens of typography, "the art preservative of all arts," but as illustrations of the perfection to which some of the manufacturing industries of the State have been carried.

Physical Apparatus.

By aid of the funds heretofore acknowledged, a few additions have been made to the physical apparatus during the year, in the branches of Heat, Pneumatics, Optics, Electricity and Mechanics, at an expense of between five and six hundred dollars. These include a galvanic battery, centrifugal apparatus, gas holders, mountain barometer, etc. The following articles have been presented:

An Air Target Pistol, by the manufacturer, *E. H. Hawley*, New Haven.
An Ellipsograph, by *Paul Roessler*, New Haven.
A Set of Photographs of Magnetic Spectra, by *Prof. Alfred M. Mayer*, Lehigh University.
A Calcium Light with Parabolic Reflector; and a number of Models, by *J. E. Earle, Esq.*, of New Haven.

Botany.

The principal botanical collections here being private property, a notice of their annual increase, which is considerable, is scarcely appropriate to this report. It is desirable, however, to form a collection of Economic Botany. The first specimens for this collection are two palmetto trees, (*Chamærops Palmetto*), presented by Professor O. C. Marsh.

Mr. J. Sumner Smith (Y. C. 1853), has given to the School his herbarium, containing about 600 specimens of plants, mostly from New Haven County. This is designed to serve as the beginning of an Herbarium of the State Flora, to be kept in the School building for the use of the students, as well as for consultation by any one interested in the plants found growing in Connecticut.

Maps and Charts.

From Maj. Gen. A. A. Humphreys, Chief of Engineers in the United States Army, the School has received a collection of Maps exhibiting the battle fields in the recent war, lying east of the Alleghany Mountains, and also the very important series of Maps of the survey of the Northern lakes, both embodying the work of the Engineers of the Army.

From Hon. E. I. Sanford, of New Haven, the School has received a copy of the Map of the South Eastern Shore of Connecticut, published from the surveys of the New York and New Haven Railroad.

From Mr. L. S. Punderson, of New Haven, we have received a copy of the Map of New Haven County, published in 1852, from the surveys of R. Whiteford.

Mr. Frank E. Hotchkiss, of New Haven, has also given to us the Maps, on rollers, of the cities of Bridgeport and New London, published in 1850, and a Map of the United States, published in 1840, and Sidney's Map of twelve miles around New York, 1840.

Metallurgy.

The metallurgical collection has been increased by the following gifts from:

T. Macfarland, Actondale, Canada. A suite of purple copper ores from Acton Mine.
Clarence King, (S. S. S. 1862), Wheeler Amalgamation Pan for the treatment of silver ores.

feriden Britannia Works. Specimens of Britannia metal.
Holmes, Booth & Haydens, Waterbury, Ct. Specimens of Brass and German Silver.
Scovill Manufacturing Co., Waterbury, Ct. Specimens of Alloys.
Jas. M. Townsend, Esq., New Haven. Suite of Gold and Copper ores, from Wilson Mine, N. C.
T. S. Woolsey, (Y. C. 1872.) A specimen of Iron ore from Litchfield Co., Conn.
Yale Lock Co., Stamford, Ct. Specimens of bronze used for bank-locks.
T. C. Trowbridge, A. H. Sibley and Thos. Macfarland. A suite of Silver ores from Silver Islet, Lake Superior.
Geo. C. Munson. Specimens of Gold and Silver ores from Colorado.

Aid for Needy Students.

A very welcome gift has been received from Rev. Leonard W. Bacon of Baltimore, in the sum of one hundred dollars, to be loaned to a student of merit who requires pecuniary help; and when repaid by such a borrower to be again loaned to some other such student. This gift it is proposed to make the nucleus of a "Loaning Fund for Students of Merit," which for several years the Governing Board have been desirous of instituting. Some of the most promising young men in the School find it very difficult to meet their current expenses. Such persons almost always prefer a loan, to be repaid from their first earnings, rather than a positive gift. It has been thought that many persons in New Haven and elsewhere would be glad to contribute sums of one hundred dollars, more or less, in aid of this class of students, if the right way were pointed out. Gifts of any amount for this purpose are earnestly solicited.

Gift from the Class of 1869.

The class which graduated in 1869, through one of their number, Mr. F. H. Willits, Ph.B., of Glen Cove, L. I., have generously presented to the Governing Board the sum of $210, to be expended in any way the Governing Board may select. It is proposed to expend this sum in the purchase of a piece of apparatus or in some important works required in the library, so as to form a constant memorial of this unsolicited liberality.

8. Number of Students.

The number of students enrolled on the catalogue during the current year 1870–71, has been 125, of whom 23 were post graduates, 94 were undergraduates, and 8 were special students. The state scholarships have all been taken up.

The names of the students for the year are given on the following pages, as a conclusion to this Report.

GRADUATE STUDENTS.

James Whitin Abbott, B.A.	*New Haven.*
Charles Augustus Brinley, PH.B.	*Hartford.*
Thomas Elwood Calvert, PH.B.	*Newtown, Pa.*
Edward Salisbury Dana, B.A.	*New Haven.*
Rev. James A. Deane, M.A., Wesl.	*Westville.*
Quincy Lamartine Dowd, B.A. Oberlin Coll.	*Seville, O.*
Augustus Jay DuBois, C.E.	*New Haven.*
Oscar Harger, B.A.	*Oxford.*
Bernard James Harrington, B.A. McGill University, Montreal.	*Montreal, Canada.*
Charles Sheldon Hastings, PH.B.	*Hartford.*
Albert Banks Hill, C.E.	*Redding.*
William Henry Hotchkiss, B.A.	*New Haven.*
John Beach Isham, B.A.	*New Haven.*
Robert Allen Hume, B.A.	*New Haven.*
William Dennis Marks, PH.B.	*St. Louis, Mo.*
Arthur Woods Rice, PH.B.	*Meriden.*
Horatio Seymour, B.A.	*Utica, N. Y.*
Sidney Irving Smith, PH.B.	*New Haven.*
James Harrison Thomson, B.A. Hanover Coll., Prof. Chem. and Nat. Sci. in Hanover Coll.	*Hanover, Ind.*
James Edward Todd, M.A. Oberlin Coll., Prof. Chem. and Nat. Sci. in Tabor Coll.	*Tabor, Iowa.*
Eli Whitney, B.A.	*New Haven.*
Henry Shaler Williams, PH.B.	*New Haven.*
Richard William Woodward, B.A.	*Franklin.*

GRADUATE STUDENTS, 23.

UNDERGRADUATE STUDENTS.

SENIORS.

Horace Andrews,	*Tarrytown, N. Y.*
Henry Wilcox Ayres,	*Hartford.*
Edwin Faxon Bacon,	*Norwalk.*
Luther White Burt,	*Hartford.*
George Benjamin Chittenden,	*East River.*
Justus Vinton Dart,	*New London.*
Russell Wheeler Davenport,	*New York City.*
William Cecil Durand,	*Milford.*
Charles Hascall Dwinelle,	*Oakland, Cal.*
Charles Addison Ferry,	*New Haven.*
Charles Henry Green,	*Cincinnati, O.*
Charles Woodford Griswold,	*New Britain.*
Philip Owen Hawkins,	*Wakefield, R. I.*

ıols Judson,	*New Haven.*
ıcculoch Keasby,	*Newark, N. J.*
ederick Klein,	*New Haven.*
anville Lobdell,	*Wilmington, Del.*
'illiam Mather,	*New Haven.*
Merriman,	*Plantsville.*
ıis Moore,	*Fond du Lac, Wisc.*
bart Pierpont,	*North Haven.*
Eugene Powell,	*New Haven.*
klin Quigley,	*Wilmington, Del.*
Lockwood Sanford,	*New Haven.*
ıdford Sargent,	*New Haven.*
linton Terry,	*Terryville.*
;en Ziegler,	*Philadelphia, Pa.*

SENIORS, 27.

JUNIORS.

kson Abbott,	*Yarmouth, Me.*
er Bogart,	*New Haven.*
enry Boykin,	*Camden, S. C.*
ristol,	*New Haven.*
l Buck,	*Orland, Me.*
ırt,	*Buffalo, N. Y.*
Stoever Dickinson,	*West Chester, Pa.*
)arlington Evans,	*West Chester, Pa.*
,eland Folsom,	*Northford.*
aunders Green,	*Cincinnati, O.*
ebster Hering,	*Johnsville, Md.*
ouis Johnson,	*Ansonia.*
evor Knapp,	*New York City.*
Wheeler Lindsley,	*New Haven.*
ster Lyman,	*Northampton, Mass.*
ar Maxson,	*Norwich.*
ouglass Millholand Maxwell,	*Wilmington, Del.*
oyes Miller,	*Lenox, N. Y.*
heodore Morse,	*New Haven.*
erkins Nevins,	*Waterford.*
Mitchell Pruden,	*New Haven.*
erthrong Roberts,	*Hartford.*
ubbard Russell,	*New Haven.*
dward Smith,	*Goshen.*
le Stickney,	*Rockville.*
ustin Tibbals,	*Brooklyn, N. Y.*
ndrews Tuttle,	*West Haven.*
ardwell Wardwell,	*Rome, N. Y.*
Floyd Weld,	*Guilford.*
renton Welling,	*New York City.*

JUNIORS, 30.

FRESHMEN.

Edgar H. S. Bailey,	*Middlefield.*
Alvah Weed Brown,	*Englewood, N. J.*
Moses Bulkley,	*Brooklyn, N. Y.*
Charles Albert Burt,	*Wallingford.*
Fillmore Cogswell,	*Washington.*
William Righter Comings,	*New Britain.*
William Allen Cowles,	*New Haven.*
Charles Adams Cragin,	*Wallingford.*
Robert John Currey,	*San Francisco, Cal.*
Annis Merrill Doolittle,	*Wallingford.*
Harry Taylor Gause,	*Wilmington, Del.*
James Elliot Gregory,	*New York City.*
Edward Julius Hall,	*Buffalo, N. Y.*
Henry Sheaff Hoyt,	*Staatsburgh, N. Y.*
Robert Jaffray,	*New York City.*
William H. Jenks,	*Brookville, Pa.*
Charles Hittel Killinger,	*Lebanon, Pa.*
Archibald McCall,	*West Chester, Pa.*
Charles Henry Matthews,	*Waterbury.*
George Christopher Moore,	*Birmingham.*
Charles Miller Morse,	*Buffalo, N. Y.*
James Augustus Nelson,	*New Haven.*
Charles Thomblin Noonan,	*Milwaukie, Wisc.*
William Josiah Parks,	*Brooklyn, N. Y.*
Walter Brewster Platt,	*Waterbury.*
Benjamin Pomeroy,	*Southport.*
Samuel Rockwell,	*Bridgehampton, N. Y.*
Amory Edwards Rowland,	*Brooklyn, N. Y.*
Edgar Camp Savage,	*Meriden.*
William Lucien Scaife,	*Pittsburgh, Pa.*
Alfred Lewis Sellers,	*West Chester, Pa.*
Charles Thompson Smith,	*New York City.*
Edward Henry Smith,	*Plainville.*
Lewis Rodney Taylor,	*Hamilton, Va.*
Aretas Whittelsey Thomas,	*Bethlehem.*
George Judson Walker,	*Buffalo, N. Y.*
Henry Goodrich Wolcott,	*Fishkill, N. Y.*

FRESHMEN, 37.

SPECIAL STUDENTS NOT CANDIDATES FOR A DEGREE.

Joseph Sampson Adam,	*Canaan.*
William G. Budington,	*Brooklyn, N. Y.*
E. B. Canhon,	*South Carolina.*
Henry Fowler English,	*New Haven.*
*B. Wistar Fellowes,	*New Haven.*
George Chestley McClean,	*Springfield, Mass.*
Wilbur Fisk Myers,	*Franklin, Pa.*
Shippen Wallace,	*Philadelphia, Pa.*

SPECIAL STUDENTS, 8.

* Deceased.

PROGRAMME

OF THE

IEFFIELD SCIENTIFIC SCHOOL

OF

YALE COLLEGE,

For the College Year Beginning Sept. 14th, 1870.

SHEFFIELD SCIENTIFIC SCHOOL.

PROGRAMME, MAY, 1871.

I.

The Three Sorts of Students.

This Institution, which is partly coördinate with a classical college and partly with professional schools, receives three classes of students:

1. Those who wish to pursue a three years course of training,* in accordance with a prescribed curriculum, largely based upon mathematical, physical, and natural science, with instruction in German, French and English; (see page 39).
2. Those who have already graduated in some college or school of science and desire to pursue advanced courses of scientific study; (see page 38).
3. Those who desire under peculiar circumstances to attend for a short time instructions in special branches; (see page 46).

These three classes are known as Under-graduates, Graduates, and Special Students.

II.

Relations to Yale College.

The relations of the Scientific Department to the Classical Department of Yale College may be thus stated;—the instructors, terms of admission, courses of study, and methods of instruction in the two departments are different; but both institutions are harmoniously organized under one Board of Trustees, and consequently the students have in common certain University privileges, and are alike entitled to become graduates of Yale College.

It is this union and this individuality which give the Sheffield School at New Haven the steadiness of a firm and well-tried institution, with the freedom of a new foundation. The combination

* Soon to be made a four years' course.

has been in many respects highly advantageous to the new department, and is probably not without some influence for good upon the old and well-known classical department. The establishment of a college of science has relieved the academic or classical college from all pressure tending to the establishment of "partial courses" of study, and has supplemented its means of instruction by new professorships and new scientific collections; while it has rendered a still greater service by giving to graduates of the classical department, opportunities for special and systematic professional training, distinct from those afforded in the schools of law, medicine, and theology.

On the other hand, the Scientific School has had the benefit of the name and repute of Yale College throughout the land. The long-established libraries and cabinets have been opened to the scientific students, who have also attended many courses of the academic lectures. More than all this, many of the officers of the classical college, by their influence, encouragement, and counsel, have given and are constantly giving to the new college assistance too valuable and enduring to be ever forgotten.

Under these circumstances, it is pleasant to add that during all the wide-spread controversies between science and letters as means of instruction, the utmost harmony has prevailed among the friends of both in New Haven.

III.

The Teachers, and their Topics.

There are eleven permanent professors who constitute with President Woolsey the Governing Board of the Scientific School, and during the coming year there will be several other instructors giving the whole or a part of their time to the work of teaching. The special courses of study will be indicated beyond. In this connection it is enough to say that instruction is given in the various branches of mathematical, physical, and natural science, with reference alike to the promotion of high intellectual culture, the acquisition of useful knowledge, and the preparation for various modern professions. While scientific and technical studies are thus made predominant, all candidates for the Bachelor's degree are also required to pay attention to linguistic studies, some knowledge of Latin being required for admission, and the *study of* German, French, and English being continued through

course. In other words, the school aims to make good lars by modern methods for modern vocations.
ıe chief Instructors and their specialties may be thus grouped:

I. ENGINEERING, ETC.

ematics and Civil Engineering.	W. A. NORTON.
anical or Dymamical Engineering,	W. P. TROWBRIDGE.
nomy, Theoretical and Practical,	C. S. LYMAN.
tical and Descriptive Geometry,	D. H. WELLS.
Surveying.	A. B. HILL.
ing, Mathematical and Free-hand,	L. BAIL.

II. CHEMISTRY, ETC.

retical and Analytical Chemistry,	S. W. JOHNSON.
llurgy and Assaying,	G. J. BRUSH. O. D. ALLEN.
entary Chemistry,	W. G. MIXTER.
ultural Chemistry,	S. W. JOHNSON.
ulture,	W. H. BREWER.
ratory Practice,	W. G. MIXTER. O. D. ALLEN.
ce,	C. S. LYMAN.

III. NATURAL HISTORY, ETC.

ralogy,	G. J. BRUSH.
ıy,	D. C. EATON.
ogy,	A. E. VERRILL. S. I. SMITH.
ontology,	O. C. MARSH.
ogy,	A. E. VERRILL.
ical Geography,	D. C. GILMAN.

IV. LANGUAGE, ETC.

ıan,	W. D. WHITNEY.
ch,	E. C. DELFOSSE.
ish,	T. R. LOUNSBURY.
ution,	M. BAILEY.
uistics,	W. D. WHITNEY.
ern History and Political Economy,	D. C. GILMAN.

IV.

ODERN PROFESSIONS FOR WHICH INSTRUCTION IS HERE PROVIDED.

is clear from what has been said that there are three marked divisions of the technical instruction here provided, namely: 1. MATHEMATICS AND ENGINEERING; 2. CHEMISTRY AND PHYSICS; 3. NATURAL HISTORY;—and that there is also provision for the ly of modern languages, geography, history, and political

economy, to which the students are required to give more or less attention. In each of the groups above mentioned there is great freedom of choice respecting the general direction which a student may take; but when the decision is made there is a definite and prescribed curriculum to which he is restricted. Students who have already pursued a liberal course of education receive advanced special instruction in science corresponding with their acquirements; while undergraduates pursue more definitely prescribed courses. In the combinations of the different classes, students are received who desire to qualify themselves for such professions and occupations as the following:

1. MEN OF SCIENCE,—either as Professors, Teachers, Explorers, Investigators, Amateurs, etc.
2. Chemists,—with reference to agriculture, manufactures, pharmacy and many commercial pursuits.
3. Metallurgists and Assayers.
4. Civil Engineers,—with reference to the construction of roads and bridges, aqueducts, reservoirs, drainage systems, and public works in general.
5. Mechanical Engineers,—with reference to the superintendence of manufactories, the invention and construction of machinery, the applications of steam, etc.
6. Mining Engineers,—with reference to the development of mineral wealth, the superintendence of mines, etc.
7. Agriculturists,—acquainted with the constitution of the soil, the laws of animal and vegetable life, the experience of other nations, etc.
8. Naturalists,—in the direction of zoölogy, botany, mineralogy, or geology.
9. Physicians and sanitary advisers,—not as pursuing here medical and surgical studies (which must be afterwards taken up in the medical schools), but in preparation for the latter by studies in physics, chemistry, botany, comparative anatomy, etc.
10. Besides all these specialists, students are received who desire by a course of training, chiefly mathematical and scientific, but likewise including linguistic and historical studies, to prepare themselves for higher studies in science, or for business, or for other professions not specified above. This course has been here selected by young men designing to become clergymen, lawyers, editors, teachers, etc.

By this enumeration it is not intended to imply that scholars who have finished a three years' course, much less that those who have been here a shorter time, are thus as a matter of course *prepared* to assume positions of great responsibility; but only that

the foundation may here be laid, in the study of principles, for various positions of usefulness and honor.

V.

Instruction for Graduate Students.

The attention of young men who have already pursued a course of liberal training in a college or school of science is invited to the opportunities here afforded for the pursuit of higher scientific studies. The Degree of Doctor of Philosophy will be bestowed by the corporation of Yale College on young men who have already taken a Bachelor's degree, and who here pursue for two or three years advanced special studies, passing satisfactory examinations, and submitting a graduation Thesis as evidence of their attainments.

During the past year, the number of post-graduate students here enrolled was twenty-eight, and the specialties to which they were devoted were very different. Great freedom in the choice of work is permitted to such students; and all the resources of the institution in teachers, apparatus, laboratories, collections, etc., are at the service of those who need them. The positions of responsibility which are open to superior persons well trained in advanced scientific studies, have never been so numerous or so inviting as they are at present.

Persons desirous of availing themselves of opportunities to pursue higher studies are invited to state their special requirements or wishes to any of the instructors, and thus to become acquainted with the facilities which the institution affords.

As examples of what may be done it may be mentioned that in Mathematics, Professors Norton, Trowbridge and Lyman, with the coöperation of Prof. H. A. Newton, will direct the studies of those who wish to avail themselves of the class instructions in the Calculus, in Analytical and Descriptive Geometry, Mathematical Drawing, Practical Astronomy, etc. The Hillhouse Mathematical Library, open for consultation daily, and the astronomical instruments belonging to the school may be freely used by advanced students. The higher course in Engineering leads to the degree of Civil Engineer.

The Chemical Laboratory is fitted for the instruction of those who wish to become proficients in practical analysis, either in preparation for professorships, technical pursuits, the medical profession, or other purposes.

Instruction in Natural History may be received in the Zoological Laboratory, where the collection, description and classification of specimens are continually in progress; or by private arrangement in the herbarium of Prof. Eaton. The public and private collections of Minerals, Ores, Fossils, etc., afford special facilities for the study of mineralogy and geology.

VI.

Instruction for Undergraduates.

The courses of study for undergraduates occupy three years; it is hoped that they will be soon extended to four years. The requirements for admission and the first year's work are the same for all this class of students; during the last two years the courses are to some extent coincident, but are chiefly special and technical.

Terms of Admission.—For admission the student must pass a thorough examination in Davies's Bourdon's Algebra as far as the General Theory of Equations, or in its equivalent; in Geometry, in the nine Books of Davies's Legendre, or their equivalent; and in Plane Trignometry, Analytical Trignometry inclusive; and also in Arithmetic, including "the Metrical System," Geography, United States History and English Grammar, including Spelling. An acquaintance with the Latin Language is also required, sufficient to read and construe some Classical author, and Allen's Latin Grammar is commended as exhibiting the amount of grammatical study deemed important. Practice in Drawing, if it can be obtained before entrance, will be of great advantage to the scholar.

Studies of Freshman Year.—In the *Mathematics*, Analytical and Descriptive Geometry, Spherical Trignometry, and Surveying (with practical field work); in *Chemistry*, recitations and laboratory practice; in *Physics*, recitations, with experimental illustrations of the subjects taken up; in *Language*, the commencement of German, and lessons in respect to the use of English with practice in writing and in elocution; in *Botany*, recitations, excursions and lectures; in *Drawing*, Binn's First Course of Orthographic Projection; perspective and free-hand drawing.

Studies of Senior and Junior Years.—At the close of the Freshman year, the students distribute themselves into various sections with reference to special lines of work; but in all these sections the study of German is continued; the study of French *is pursued*; and practice in writing English is required. Drawing

also occupies a part of the time. At the close of three years, every candidate for a Bachelor's degree presents a Thesis as evidence of his powers of investigation and his capacity as a writer.

In each section, the students attend to some of the studies appropriate to other sections; thus Geology is taught to all the scholars; Zoölogy to the students in Chemistry as well as to those in Natural History and in the select course; and so on.

The Special courses most distinctly marked out are the following:

(a) In Chemistry and Metallurgy;
(b) In Civil Engineering;
(c) In Mechanical or Dynamical Engineering;
(d) In Agricultural;
(e) In Natural History;
(f) In studies preparatory to Medical Studies;
(g) In studies preparatory to Mining;
(h) In select studies preparatory to other higher pursuits, to business, etc.

(a.) In Chemistry and Metallurgy.

The Sheffield Laboratory is fitted up in a complete and convenient manner, is provided with all the requisite apparatus and instruments of research, possesses a considerable collection of chemical preparations, and has a consulting library of the best treatises on Chemistry and the Chemical arts. It affords facilities for instruction in the various branches of theoretical and practical Chemistry.

The Laboratory is open for chemical practice seven hours daily, for five days of the weeks, but is closed on Saturday. The student works through a course of qualitative and quantitative analysis, which is varied according to his capacity and the object he has in view. Each pupil proceeds by himself independently of the others, under the constant guidance of the Instructors.

The regular students in Chemistry are prepared for chemical work by their practical exercises in the Laboratory during Freshman year. In the Junior and Senior years they are required to occupy four to six hours in the Laboratory each working day. Special Students who have not had adequate instruction in inorganic chemistry are required to join the Freshman class in Eliot and Storer's Manual.

Junior students have recitations in Analytical Chemistry and Lectures on Theoretical and Organic Chemistry.

Senior students have recitations and lectures on Agricultural Chemistry and Metallurgy.

Mineralogy is taught in the Junior year by lectures, which are

fully illustrated with hand specimens and models, and by weekly exercises throughout the Senior year in the identification of minerals from physical and chemical characters.

Instruction is also given in Metallurgy, and especial attention is devoted to assaying and the investigation of ores and furnace products. The student in Agriculture has opportunity to acquaint himself with the modes of research employed in agricultural chemistry. The applications of the science to other branches of industry are taught as occasion requires.

To advanced students, whether belonging to the regular classes or not, who desire to give attention to particular branches of chemistry, or to pursue original investigations, every facility is accorded.

The private libraries of the professors, containing the chemical journals and the recent foreign literature of chemistry and mineralogy, the large collections of ores, furnace products, &c., belonging to the School, and the extensive private cabinet of the Professor of Mineralogy, are freely used as aids in instruction.

(b.) In Civil Engineering.

The special course of Civil Engineering comprises the following departments of study:

1. *The Higher Mathematics*, consisting of Spherical Trigonometry, higher Analytical Geometry, Differential and Integral Calculus, Descriptive Geometry and coördinate branches of study, &c.
2. *Applied Mathematics*, which includes all the field operations and plotting comprised in the various branches of Practical Surveying.
3. *A Course of Drawing*, comprising Binn's Course of Orthographic Projection, with application to mechanical and engineering drawing; shading and tinting; Linear Perspective; Free-Hand Drawing; Isometrical, Topographical, Architectural and Structural Drawing.
4. *Theoretical Mechanics;* and *Mechanics applied to Engineering* in the construction and operation of machines, the utilization of water power, the employment of prime movers, including hydraulic motors, and the Steam Engine, &c.
5. *Field Engineering*, which embraces the laying out of curves, and all the field operations necessary in locating a line of road, establishing the grade, and determining the amount of excavation and embankment, &c.

Civil Engineering, proper; or the Science of Construction, in its various departments,—including, among many other topics, the strength of materials, the establishment of foundations, the construction and stability of walls and arches, the theory and detail of the construction of bridges, roof trusses, &c., in wood and iron, and the graphics of stone cutting.

Students who pursue a higher course in Engineering, for one ear after graduating as Bachelors, may receive the degree of ivil Engineer.

(c.) In Dynamical Engineering.

This course comprehends in its various branches of study and eparation, all that have an immediate bearing on Industrial ırsuits, requiring the use of

Instrumental Drawing. Beginning with the elements of drawing, the students receive continuous instruction in all the conventional modes and practices of representing objects, machines, or structures, from the study of the objects; by plans, elevations, sections, shading and coloring, while at the same time, and by graphical representation, they learn the detailed construction of all classes of machinery, the application of mechanical movements, and the modes of transmitting motion and power. To these ends a large collection of standard drawings, models, and machines, has been obtained and arranged for ready reference.

The Higher Mathematics. Spherical Trigonometry, Analytical Geometry of three dimensions, Differential and Integral Calculus—and Descriptive Geometry.

Applied Mathematics. Analytical Mechanics. The principles of Thermodynamics, or the application of mathematics to the investigation of the laws of heat, the principles of Cinematics or the comparison of motions; the theory of mechanism.

Applied Mechanics and Thermodynamics. The application of mechanics Cinemetics and Thermodynamics to the construc tion of boilers, or steam generators, the construction of steam or heat Engines, the construction of water wheels, shafting, gearing, and the construction, and use of tools and machines, for performing all kinds of useful work, the construction of iron bridges and structures of iron, the properties of materials as regards resistances to strains, or stresses, elasticity, durability, chemical reactions. friction, etc.

5. *Dynamic Engineering.* The application of the principles of mathematics, mechanics, cinemetics, themodynamics, mechanism, properties of materials to Industrial operation, steamships, railway motive power, manufactures, mills, forges, fabrication of materials, heating and ventilation, the utilization of water power, draining, and irrigation, wind mills, &c.
6. For students desiring to take a degree of Dynamic Engineer, two additional years will be required, during which the application of the foregoing studies will be continued in connection with the examination of existing works of industry in the various branches, and the exercises will be extended to the planning of such works, and the original designing of the various kinds of machinery applicable to them.

(d.) In Agriculture.

Students in this department, in addition to those general studies needed for mental discipline or general knowledge and culture, receive instruction in Agricultural and Analytical Chemistry, Vegetable Physiology and Botany, Zoölogy, Entomology, Geology, the culture of our Staple Crops, the Principles of Stock Breeding and Rearing, and Rural Economy. These instructions are given partly by lectures and partly by recitations.

In the coming year, the lectures on stock breeding, rural economy and the cultivation of crops, will be given during the fall term only.

(e.) In Natural History.

Either Geology, Mineralogy, Zoölogy or Botany may be made the principal study, some attention in each case being directed to the other three branches of Natural History.

1. In Botany the extended course begins with Structural and Physiological Botany, taught by text-book, lectures, and practical work with the microscope. Excursions and practice in indentification of species and proper preservation of specimens follow. Familiarity with standard botanical literature is encouraged, and lastly, students are taught to record their observations in scientific language, and to contribute, if possible, something to botanical science.

2. In Geology the instruction consists of recitations in Dana's Manual, illustrated by specimens of minerals, rocks, and fossils. Excursions are made to interesting localities to illustrate certain *principles* of the science which can be best studied in the field.

Special students in geology pursue the practical study of fossils in the zoölogical laboratory, and of minerals and rocks in the chemical laboratory.

3. The instruction in Zoölogy includes courses of lectures on systematic zoölogy, comparative anatomy, and the geographical distribution of animals, illustrated by specimens and a large number of diagrams; excursions for the purpose of studying the habits of living animals and collecting specimens; and practical instruction in the zoölogical laboratory in comparative anatomy, embryology, and the identification, description, and classification of animals, together with their preservation and arrangement. The purpose is, in every case, to induce habits of close observation and accurate generalization, and finally, to lead the student to make original investigations upon the objects of his study.

4. In Mineralogy a course of lectures on elementary crystallography, and the physical properties of minerals, their chemical composition, classification, and the detailed description of mineral species, illustrated by constant reference to the mineral cabinets. Also a course of practical exercises in blowpipe and determinative mineralogy.

(f.) In preparation for Medical Studies.

During one year the work of this course will be chiefly under the direction of the instructors in Chemistry; during the second year under that of the instructors in Zoölogy and Botany. In Chemistry especial attention will be given to the examination of urine and the testing of drugs and poisons; in Zoölogy to comparative anatomy, reproduction, embryology, the laws of hereditary descent and human parasites; and in Botany to a general knowledge of structural and physiological Botany, and to medicinal, food-producing and poisonous plants.

(g.) In studies preparatory to Mining.

Young men desiring to become Mining Engineers, can pursue the regular course in civil or mechanical engineering, and at its close can spend a fourth year in the study of metallurgy, mineralogy, etc. Should there be a sufficient number of students desiring it, a course of lectures on the subject of Mining will also be provided.

(h.) In select studies preparatory to other higher pursuits, to business, etc.

In accordance with a demand for systematic instruction in scientific studies, without reference to technical pursuits, and with a just regard to intellectual culture, a course is arranged as a basis for higher scientific pursuits, for teachers, business men, those designing to engage in editorial work, and others. This course in addition to the instructions in German, French and English, common to all departments of the school, includes instruction from Prof. Whitney in the general principles of Language, and from Mr. Lounsbury in the critical study of the English language, in its structure, history and literature. Constant practice in writing is also required. Students desiring to pursue the study of Latin, or of other languages, can easily make arrangements for doing so, if their time permits. The course also provides systematic instruction in the Physical Geography of the globe; in the special physical and historical geography of Europe and the United States; in the outlines of Modern History, and in Political Economy. The students in this course receive from the various professors instruction in Agricultural Chemistry, Botany, Zoölogy, Geology and Mineralogy. They attend the lectures on Agriculture, Rural Economy, Stock Breeding, etc., and those on General and Theoretical Chemistry. Their mathematical studies are continued in Astronomy. They are expected to keep up the practice of Drawing, especially of Free-hand drawing. So far as it does not interfere with appointments in the school, students in this course are permitted to attend the lectures of President Woolsey, Dr. Sanford, and other lecturers in the academical department.

VII.

Instruction for Special Students.

For the benefit of those who desire to pursue some particular studies, without reference to a college degree, most of the various instructors are willing to receive special students for a longer or shorter time. Only persons of mature minds are received.

For example, in Agriculture the instruction is so arranged that by attendance during the ensuing autumn term, the scholar may hear the various lectures, and receive as much technical instruction in this one branch, as by remaining through the winter.

In the chemical laboratory, students properly qualified are *received* for short periods of work.

In the various departments of Natural History special lessons ill also be given.

Instruction may also be received in Practical Astronomy and e use of instruments.

It should be distinctly understood that these opportunities are ıt offered to persons who are incompetent to go on with regu- r courses, but are designed to aid those who have been educated ıewhere to increase their proficiency in special branches.

VIII.

BUILDING AND APPARATUS.

Sheffield Hall, bearing the name of the donor, Mr. Joseph E. ıeffield, of New Haven, is a large and well arranged building ıntaining recitation and lecture rooms for all the classes, a hall r public assemblies and lectures, laboratories for chemical and etallurgical investigations, a photographical room, an astronomi- ıl observatory, museums, a library and reading room, besides udies for some of the professors, where their private technical braries are kept.

The following is a summary statement of the collections belong- ıg to the School:

. Laboratories and Apparatus in Chemistry, Metallurgy, Mechanics, Photography and Zoölogy.

. Metallurgical Museum of Ores, Furnace Products, etc.

. Agricultural Museum of Soils, Fertilizers, useful and injurious Insects, etc.

. Collections in Zoölogy.

. Astronomical Observatory, with an equatorial telescope by Clark and Son of Cambridge, a meridian circle, etc.

. Library and reading room, containing the "Hillhouse Mathematical Library," books of reference and a selection of German, French, English, and American scientific journals.

A collection of Physical Apparatus, constituting "the Collier Cabinet,"—recently bought by Prof. Lyman.

Models in Architecture, Civil Engineering, and Mechanics, and diagrams adapted to public lectures.

Maps and Charts, topographical, hydrographical, geological, etc.

e mineralogical cabinet of Professor Brush, the herbarium of Prof. Brewer, the collection of native birds of Professor Whitney, and the astronomical instruments of Professor Lyman, are all deposited in the building. Prof. Eaton's herbarium, near at hand, is freely accessible.

Students in this department are also admitted to the College ıd Society libraries, the College Reading Room, the Cabinet of ineralsand Fossils, the School of the Fine Arts, and the Gym ısium for physical exercise.

IX.

Lectures.

The instructions of this institution are given chiefly in small class rooms, by recitations or familiar lectures, illustrated by all the apparatus at the command of the various teachers. A public course of lectures is given every winter on topics of popular interest. On Sunday evenings during a portion of the year, lectures are given by resident clergymen of different denominations, and by members of the Theological and other college faculties. A course of lectures on the Preservation of Health, by Dr. Francis Bacon, Professor in the Medical Department, may be expected on Saturday mornings at the beginning of the autumn term.

X.

Tuition Charges.

The tuition charge is $150 per year. Besides this there is a charge of $5 annually for the use of the academical reading room and gymnasium. Freshmen pay $5 for chemicals; and the special students in the chemical laboratory are likewise charged $25 per term, for the materials they use—besides breakage. The Graduation fee is $10.

Vacations correspond with those of the academical department.

XI.

Church Sittings.

Free sittings for students in this deparment of Yale College are provided as follows:

In the Center Church (Cong.), Rev. G. L. Walker, D.D.: Pews No. 36 and 42, in the North Gallery.

In Trinity Chuch (Episc.), Rev. E. Harwood, D.D.: Pews No. 175 and 177, in the North Gallery.

In the First Methodist Church, Rev. G. W. Woodruff, D.D.: Pew No. 78, at the head of the West Aisle (below).

Any of the students may occupy a sitting in these slips. Those who prefer to pay for a sitting for a year, more or less, in the churches above mentioned, or in any other church of any denomination, will be aided on application to the Treasurer or Secretary of the School.

Sittings in the Gallery of the College Chapel are free as heretofore to the students of this department.

APPENDIX TO THE SIXTH ANNUAL REPORT.

CATALOGUE OF DRAWINGS

EXHIBITING THE

ENGINES, MACHINERY, ETC.

MANUFACTURED BY

THE NOVELTY IRON WORKS, NEW YORK.

PRESENTED BY THE NOVELTY IRON WORKS TO THE SHEFFIELD SCIENTIFIC SCHOOL, SEPTEMBER, 1870.

CATALOGUE.

FIRST SERIES.

.. **Jib Cranes and Crabs for Docks.**
Hoisting Crabs for A. O. 4 and 5′. Do. for "Atlantic." Do. for "Baltic." Do. "Yznaga." Crane on Dock Novelty Iron Works. "E. S." Crane. Independent Crane.

l. **Cone Valve Oscillators.** Model Engine. Horizontal Engine.

l. **Miscellaneous Drawings of Beam Engines built years ago.**
Lighthall's Half Beam Engine on U. S. S. "Jefferson." Cylinder for Steamer "Peru." Bed Plate for Steamboat "Astoria." Cylinder for Steamboat "Swan." Cylinder and Shaft for Steamboat "Narragansett." Injection Valve for Steamer "China." Cylinder for Steamer "Proprietor." Shafts for "Cypress." Steam Chest for Steamer "Anesseah." Details of "Wasp," Con. Rod, Crank, Crossheads, &c. Shaft for "Cuba." Shaft for "Vixen." Beam Strap for "Boston." Cylinder and Condenser for "Boston." Cylinder for "Palm."

l. **Stocks and Dies, Blocks, Falls, &c.**
Double Tackle Blocks, S. L. 30. Brass Sheave Blocks, G. A. 3 and 4. Ratchet Drills, Works, Tool Repairs.

. **Saw Mill Engines.**
Hunt's Saw Mill Engine. Cook's Saw Mill Engine, Portable.

. **Mining Machinery.** New York Ore Dressing Co. New York Zinc Co.

. **Ore Crushers and Stampers.**
New York Ore Dressing Co.'s Crusher. Bristol Crusher. Berdan's Crusher. Berdan's Stamper. Plumb's Crusher. Bullock's Crusher. Garden's Crusher. Hand Quartz Machines. Stillman's Crusher. Berdan's Model Crusher No. 8.

.
James Hamilton's Indigo Mill and Crusher. Tatham Bros.' Measuring Apparatus.

. **Mixing Tubs.** New Jersey Zinc Co. D. F. Tieman B. 258.

0. 11. 12. 13. 14. 15.

6. **Hoisting Apparatus for Stores, &c.**
Shaw's Hoisting Gear. C. M. Diamond's Hoisting Machinery. Havemeyer & Muller's Hoisting Machinery. Harris, Evans & Co.'s Hoisting Machinery. Haviland & Co's Hoisting Machinery. "Maid of Orleans" Hoisting Machines. Stuart's Hoisting Machines. Automatic Elevator.

7. **Portable Engines.** Portable Engine No. 1. P. O. Engine.

8. **Wrenches for**
"Santa Anna;" G. A. 3 and 4; S. L. No. 31; I. O. 19 and 20; Hydraulic Engine; A. O. No. 1; "Adriatic;" A. No. 26; A. O. No. 2; "Alabama;" Yznaga's Engine; Nile Pumping Engine; "Rio;" Vacuum Pan No. 34; A. B. No. 58; B. No. 10; A. B. No. 18.

19. Retorts and Stills for Distilling.
Cleaver's Kettles. Sheridan's Kettles. Miller's Still. Adams' Kettles. Johnson & Sanford's Kettles. Wade-Kettle. Neffy-Pan. Brown & Irving's Still. Kelly, Briggs & Co.'s Soap Pan. Brundage & Co. Salazer's Soap Kettles.

20. Harris & Evans' Sugar House Work.

21. Lowber's Cotton Seed Huller.

22. Pendulum Engines, 28′ x 42′.
Nos. 1 and 2.

23. Ribbon Engine for Stern Wheel Boat.

24. Delgardo's Rice Mill Work.

25. Hutchinson's Work.
Skimming Spout. Bell Fixtures, E. Lind. C. 136 and C. 143 for Don Nicholas Plaud. Feed Pumps for Mount Victory. Cattle Mill for Don Felix Clauzell. Piston for E. Lind. Work for Don Jacinto Cora. Work for T. Harper. Work for A. Vilaret. Work for Don Juan Pou. Crosshead for Estate L. Bethelem. J. Gaicur's Crosshead. Don A. Vilaret's Cattle Mill Gear. C. 131, Don Juan Anglado. Estate Gregoria. C. No. 394, Wrought Iron Tank for Nicholas Plaud. Rock Shaft for Don S. Antonetie. Clauzel Hermanos. Brasses, Don T. E. Boyrie. San Juan, Estate. Clarifier Pipes, Eelix Clauzel.

26. Berdan's Automatic Oven.

27.

28. Traverse Iron and Gun Fixtures for Forts.
C. 12, C. 258, C. 9, C. 81; C. 711, Block and Hook for Diving Bell.

29. Pillow Blocks, Hangers, Pulleys and Fly Wheels.
Engine D. 14, Fly Wheel. Do. E. 8, 9 and 10, Fly Wheel. Do. B. 10, Fly Wheel. Do. 15′ x 36′, Fly Wheel. Water Wheel Shaft for Ivanhoe Mills. Meyer & Popenhausen, Shafting. Do. Pulleys. Hangers for 1¼″ and 2″ Shafts. Fisher & Bird's Fly Wheel. H. P. C. 10 x 20 Fly Wheel. H. P. C. 12 x 24′ Fly Wheel. H. P. C. 14 x 30′ Fly Wheel. 18 x 4, 3, Fly Wheel. Mortise Wheel for Sloan & Leggett.

30. Crane Alterations. I. O. Nos. 23 and 24.

31. Blowing Engines. "Roanoke" Blowing Engine. "Gen. Admiral" do.

32. Blowing Engines.
"City of New York." A. B. 58. S. L. 30. A. B. 17. "Alabama." "Northerner." "Augusta." "Metropolis." A. O. 1. "Ash and Oak." A. O. 3. A. B. 51.

33. 34. 35. 36. 37.

38. Havana Arsenal Works.
Cupolas. Building for Rolling Mill. Rolling Mill. Bed for Break Lathe. Plate Bending Machine.

39. Tucker & Cooper's Square Engine, 26 x 48.

40. Johnson's Shutter Machine. Sectional Dry Dock Work.

41. Engine Designs of various kinds.
Lake Propeller Engine, 182. Engine Space, comparison of Engines. Proposed Plan for the "Rio." Do. for Pumping Engine. Do. for Russian G. B. Engines. Plan of "Constitution," for German line. Engines for Rebel Ram "Merrimac." Do. for "Gen. Admiral." Do. for "Minnesota." Stern Port Bearing for "Megera." Engine of Sloop of War "Iroquois." Sugar Mill Engine. Engines for U. S. Sloops of War at Gosport. H. P. Oscillator Propeller. Vertical Pumping Engines.

42. Johnson's Engine for China. New York and Costa Rica Condenser, &c.

. Nos. 1 and 2 Newtown. S. C. Ferry Boats.

. Four Ferry Boat Engines, A. B. 52, 53, 54 and 55.

. Tracing of Ferry Boat "D. S. Gregory."

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. **Cut Offs.**
Campbell & Thayer. Horatio Allen. Harlan & Hollingworth. Mathews & Moore. J. F. Ward. Sutton & Co. I. P. Morris & Co. Tucker, Cooper & Co. Danbar & Bartley. Pease & Murphy. "Underwriter." Merrick & Son. Betts, Pursey & Co.

. Yzanga's Engine.

.
L. F. Nos. 1, 2, 3, 4, 5 and 6. A. Fitch. Shop. Hazard Powder Co. Hoe & Co. Tatham Bros. Bellingham Steam Engine Co.

. L. F. Nos. 5 and 6.

. B. F. Nos. 7 and 8; Sloan & Leggett.

. Lee & Larned.

. Lee & Larned.

. Lee & Larned.

. Fire Engine Alterations for Horses.

. **57.**

. "Adriatic."

. A. O. 4 and 5 or "Arago."

. "Adriatic."

. "Webb" or "America." "Santa Anna" or "Edgar."

. "Adriatic," Alterations.

. "Russia" or "Japanese."

. "Golden Gate" or "G. G."

. I. O. 19 and 22, or "Ashuelot" and "Pawtuxet."

. A. O. No. 1 or "Augusta." A. O. No. 3 or "Knoxville."

. "Siam Engines." "Rio" Engines.

. A. O. No. 2, "John L. Stephens."

. **70. 71. 72. 73. 74. 75. 76. 77. 78. 79. 80. 81. 82. 83. 84. 85. 86. 87.**

. **Deck Plans, &c.**
"Arago," Midship Section. "Berry," do. "Ash and Oak," do. "Peru," do. "Lion and Eagle," do. "Russia," do. "Cherokee," do. A. B. 17, Gallows Frame. "Boston," Deck Plan and Gallows Frame. "Oregon," Gallows Frame. "June," do. "Wm. No. 2," Deck Plan and Gallows Frame. "Hornet," Gallows Frame. "Vixen," do. "Newport" (1846), do. "Erie," do. "Cuba," Deck Plans. "Eagle," do. "Siam I," do. "Rio," do. "Quinebaugo," do. Design for Ferry Boat. "Franklin," general arrangement of Machinery. A. O. Nos. 4 and 5, Boiler Keelsom. N. and S., general arrangement. A. B. No. 67, "Newport Section." S. L. 30 and 31, Suspension Frame. "Guadaloupe," do. "Berry," do. "Southerner," do. "Northerner," do. "Santa Anna," do. A. O. No. 2, do. A. O. No. 4, do. Johnson's Engine," Section and Gallows Frame. "Berry," general arrangement of Machinery.

89. General Plans, Marine Engines.

H. D. Nos. 63 and 64, "Wampanoag." S. L. No. 30, "Nashville." J. B. 2 and 3, "Monterey" and "Mariposa." G. A., "General Admiral." G. A. 3 and 4, "Re de Italia." "Humboldt." "Atlantic." "Florida." "Golden Gate." "Adriatic." "Arctic." I. O. 19 and 22, "Ashuelot" and "Pawtuxet." "Webb" or "America." A. B. No. 58, "Constitution." A. B. No. 2, "John L. Stevens." G. B. Nos. 5 to 12, "Unadilla," "Seneca." "Pembina," "Ottowa." J. B. No. 1, "North Carolina." G. B. 13 to 18, "Arcostook," "Kennebec," "Ottowa." I. E. No. 16, "Sebago." I. E. 17, 18 and 19, "Port Royal." "Sonoma." "Conemough." "N. and S.," "Florida" and "Alabama." G. B. 1 to 4, "Franklin." "Berry" or "Marion." "Columbia." "Leon" (Spanish Steamer). "Lion and Eagle." "Guadaloupe." "Arctic." "Northerner." "Ash and Oak." "Palmetto." "Hermann." "Perio." "Elk and Deer." Edgar" (Mexican Steamer). "Russia." S. W. 1 and 2, "Adriondack."

90. Deck Plans, &c.

A. O. 4 and 5, or "Arago." "Humboldt." "Russia." I. O. 19 and 22, "Ashuelot" and "Pawtuxet." "Rio." A. B. 58, "Constitution." A. B. 60, "Sacramento." A. B. 60. A. B. 66. A. B. 63. A. B. 59. A. B. 61. A. B. 62 and 65. "Joseph Belknap," Gallows Frame. "Northerner," Deck Plan. I. E. 13 and 14, Framing. G. A. 3 and 4. G. A., and G. A. 3 and 4, Deck Plan. I. E. 15, Engine Frame. I. E. 16, do. I. E. 17 to 19, do. "Cromwell," Deck Plan. "Arctic," do. I. E. 18 and 19. "Ribbon." "Cromwell," Keelson. Plan of Steam Yacht. I. E. 17, Deck Plan and Frame. "Adriondack." A. O. 1. A. B. 17, Suspension Frame. "Atlantic." Iron Deck. "Atlantic." "Columbia." "Havre," Deck Plan. "Arctic, do. S L. 31. A. B. 18. Gallows Frame. Proposed Plan of Steam Lighter. "Berry" or "Marion," Boiler Keelsom. A. O. 2. "Adriatic," Suspension Frame. S. E., Frame. "Washington," Suspension Frame. "Newport," Gallows Frame. "Cuba," do. "Edgar" or "Santa Anna." "Albemarle," Iron Steamer. "Golden Gate," Suspension Frame. "Elk and Deer" or "California," and "Oregon," A Frame. "A. O. 4 and 5," Deck Plan. "Peru," do.

91. Steamboat Engines. General Plans.

I. E. 7, 8 and 9. "Rio." "Siam." "June." "Comet." "Oregon." "Erie." "Wasp." "China" or St. Lawrence." "Boston." "Hornet." "Newtown." for Ferry Boat "Martha." A. B. 51, "Long Island." "Tigress." "California" or "Wm."

92. Wrought Iron Vessels.

"Rio." "Ribbon." "Vencedor." Plan of Iron Boat for Captain Newton. Do. for Coast Survey.

93. Stationary, Beam, and Pumping Engines.

N. O. Pumping Engine. Pumping Engines, E; P. E. B. 17 and 18 (Polk's); D.; C. A.; B.; F. 1. High Pressure Engine 120, H. P. for Chas. Edmonston; V, 12 x 24. L. F. 2. B. F. P. 1. V, 3 and 4. Engine 4" x 26". L. F. 6. Vertical Beam Engine, 8 x 18. L. F. 9, and Nile Pumps.

94. Plan and Arrangements of Sugar Work.

General Plan of Engine and Mill "C." Yznaga's Arrangement. Bradin's do. Sugar Mill C. 11. O'Hard, Jacobs & Co. Don Juan Vivas. Valcour Aime. Fortier Brothers. C. K. Diamond. Mill D. 3 and 4. E. 20. I. & H. Perkins. Bringiers, Clarifers. Gordon's Plantation. Latory. James Porter. Henry M'Call. DeForest's. Wilkinson's. Lapices. Kennee. Dominique De Lober. Tillotson. Lanfear & Polk. Mill F. 3. Massary. Bringiers' Tiger Arrangement. Barrows'. Perkins'. Mill D. Fernandy. Mill I. 2, Arrangement. C. 11, do. Craig's do. Osgood's do. Bliss' do. Mill D. 7 do. McManus' do. Forestall's do. Joubert do. Colton do. Cook & Caldwell's do. Johnson's do. E. 6.

5. Stationary Horizontal Engines and Steam Pumps.
Hor. H. P. Engine, 12 x 30. Do. No. 7. H. P. Con. Rod Engine, 15″ x 3′, No. 5. Steam Pump B. No. 1. Do. No. 1. Do. Nos. 5 and 6. Congress Pumping and Blowing Engine. Pumping Engine S. L. No. 30. "Russia" Steam Pump. G. B. 13 to 18 do. Engine Z. No. 1. Oscillator No. 1. Hunt's Engine. Portable do. Ribbon do. 5 Horse Engine, New Plan. H. P. Con. Rod Engine. Engine E. Nos. 1 and 2. Do. 20″ x 4′, No. 2. Do. 8½″ x 30″, A. No. 26. Do. 15″ x 3′, No. 6. Do. 5″ x 12″. Do. H. D. No. 94, 6″ x 12″. Franklin Elevating Engine. Atlantic's Blowing Engine. H. P. Con. Rod Engine, 8″ x 18″, Nos. 2, 3, 4 and 5. Roanoke Blowing Engine. Crane Alterations, I. O. 23 and 24. Borden's Engine. Blowing Engine, I. E. 18 and 18.

6. H. P. Engines. Arrangements of Pipes.
Campbell & Moodie. Improved Steam Saw Mill. New Orleans Cotton Press Co. Rolling Mill Engine, A. No. 8. Engine 20″ x 4′, No. 2, for Jewell & Son. Johnson's Draining Wheel. Engine A. 30 and 34, Freeman's. Tucker & Cooper. Deits & Brothers. F. No. 3, Engine. E. Nos. 8, 9 and 10, do. Yznaga's do. H. P. Con. Rod Engine, 14″ x 3′. Old Shop Engine. Johnson's Flour Mill. House of Refuge. Doanes. Fowler. Lowber. Lamens. Engine, 18″ x 3½, No. 1. Do. E. No. 2, Noah Waterbury. Thompsonville Carpet Co. N. Y. Dyeing and Printing Co. Engine, D. 10 x 11, Murdeck's. Latory's. Stoddard & Dunham. Forsythe & Simpson. Engine G. No. 1. Brick Arrangement.

7.

8. Wheels and Propellers.
Water Wheels.—A. B. 61. "Siam." A. B. 58. A. B. 59. A. B. 60. "Rio." L. P. 30. "Atlantic." "N. & L." A. O. 2. "G. G." "Columbia." A. O. 4 and 5. "Adriatic." "Arctic." "Berry." "Elk and Deer." "Metropolis," Proposed Plan. "Lafayette." A. B. 17. "Webb." A. B. 51. "Wm." "Ash and Oak." "Santa Anna." A. A. 18. A. O. 1. "Northerner." "Newtown." *Propellers.*—"Russia." I. O. 19 and 22. "Adriondack." G. B. 13 to 18. G B. 19 to 22. "Revenue Cutter." "H. D. 63 and 64."

9.

0.
A. B. 56 and 57. "City of Boston" and "City of New York," or "Mohawk" and "Yantic."

1. "Atlantic," Details and Repairs. V. D. 92 and 93.

2. A. B. 18 and 51, or "Fairhaven" and "Long Island" Ferry boats.

3. "Atlantic."

4. A. B. 17, or "Metropolis."

5. "Atlantic."

6. A. B. 17, or "Metropolis."

7. "Arctic."

8.

9. "Baltic," Repairs.

0. S. L. 30 and 31, "Nashville" and "Columbia."

1. "Havre."

2. "Columbia," for the Pacific.

3. "Franklin."

4. N. and S. and "Berry," "Alabama," "Florida."

5. "Washington," "Hermann," "Lafayette."

116. "Ash and Oak," or "Cherokee" and "Tennessee."

117. "Northerner," "Elk and Deer." or "California" and "Oregon."

118. H. D. 63 and 64, or "Wampanoag."

119. **Horizontal High Pressure Engines, New Patterns.**
17 x 24, Sackett & Mackey.

120. H. D. 63 and 64.

121. S. W. 1 and 2, "Adriandack."

122. H. D. 63 and 64.

123. S. W. 1 and 2.

124. G. A. 1 and 2, "General Admiral."

125. G. B. 19 and 22, "Miantinomah."

126. G. A. 1 and 2.

127. G. B. 13 to 18, "Aroostook," "Kennebec" and "Owasco."

128. G. A. 1.

129.
G. B. 1 to 4, for "Russia." G. B. 5 to 12, "Unadilla," "Seneca," "Pembina" "Ottawa."

130. G. A. 3 and 4, "Re d' Italia."

131. V. D. 68 and 69, "Clara Clarita."

132. Copied Drawing of "Wampanoag," for Navy Dep't.

133. J. B. 1, Cromwell's Iron Boat, "North Carolina."

134. "Roanoke's" Alterations.

135. J. B. 2 and 3, "Monterey" and "Mariposa."

136. 137. 138. 139. 140. 141. 142. 143. 144.

145. **Horizontal H. P. Engine, New Patterns.**
G. 528, Burr & Black, Louisville, Ky. G. 978, Acadia Coal Co., Nova Scotia.

146. 147. 148. 149. 150. 151. 152. 153. 154.

155. **Sea Valves for Steamers.**
G. A. 3 and 4, Pacific Mail Steamers. Stills for Making Fresh Water. Fortier & Brother. B. 389, Morten's Heaters. I. O. 19 to 22, Fresh Water Apparatus. E. 72.

156. **New Orleans Pumping Engine.**

157. **Delgardo's Beam Engine.** A. 60.

158. **Nile Pumping Engine.**

159. **Beam Engine.** H. 1. Do. B. F. 1.

160. **Borden's Pumping Engine.**

161. **Beam Engine.** C. B. 4 and 5. Velodius and S. B. Massary.

162. **Pipes and Work for Silver Lake Mine,**
Dutchess Co., N. Y. Geo. H. Brown.

163. **Beam Engine.**
C. A. 1, 2 and 3, for A. N. Jubert, Guyana, Ollara Jacobs' Estate, Concordia

164. I. E. 16, "Sebago."

165. **Bridges, Post's Patent Truss.**

166.
I. E. Engines for Ferry boats. I. E. 78 and 9, "Lydia," "Addie," "Agnes." I. E. 10 and 11, "Ellen" and "Louise." I. E. 12, "New York of Albany." I. E. 13. 14 and 15, Dr. Rainey's 3 Ferry boats.

167. **Bridges, Post's Patent Truss.**

168. I. E. 17, 18 and 19, "Port Royal." "Sonoma," "Connough."

169. **Beam Engine,** S.

170. **Dredging Boat for New Orleans.**

171. **Steam Pumps,** A. B. and 2.

172. **173. 174. 175. 176. 177.**

178. **Horizontal Engine Designs.**

179. **Borden's Hoisting Engines, for Mines.**

180. **H. P. C. Engines,** 15 x 36.

181. **Governors for Engines.**
Engine, 15 x 36, 6. Do. A. 26. H. P. Con. Rod, size 2. Do. 5, 8, 9 and 10. Do. 7. Do. 14 x 48.

Chronometric Governors.
P. M. S. S. Co., Gov. Acct. L. F. 2. Engine, 18 x 3½. Brower's. N. Y. Brick Co. C. A. 1, 2 and 3. Pumping Engine, B. 19. Silver's Governor.

182. H. P. C. Engines, 14 x 24. Do. 14 x 30. Do. 14 x 48.

183. **Horizontal Engines, (Old Pattern.)**
D. 12 x 48. E. 15 x 48. E. 16 x 48. F. 18 x 48. G. 20 x 48.

184. H. P. C. Engines, 6 x 12. Do. 8 x 18. Do. 10 x 20. Do. 10 x 24. Do. 12 x 24. Do. 12 x 30.

185. **Horizontal Engines, (Old Pattern.)** 18 x 42.

186. **Valve Gear for H. P. Engines.** Stephenson's.

187. **Horizontal Engine, (Old Pattern.)** B. 10 x 36. C. 12 x 36. X. 15 x 36.

188. **Repairs for H. P. Engines, Cylinder Valves.** Morten's Engine.

189. **Horizontal Engines, (Old Patterns.)** A. 8 x 30.

190.

191. 5 H. P. Engine, New Series.

192. A. B. Engines, (58—102.) Cast Iron Work. Main parts common to all.

193. A. B. 67. "Newport."

194. A. B. Engines, (58—102.) Wrought Iron Work. Main parts common to all.

195. A. B. 67. "Newport."

196. A. B. Engines, (58—102.) Valve Gear and Instrument Fixtures.

197.

198. A. B. (58—102.) Valves and Strainers.

199.

200. A. B. (58—102.) Pipes and Tanks.

201.

202. A. B. (58—102.) Galleries.

203. A. B. 60.

204. A. B. (58 to 102.) Scale Drawings and Wood work.

205. A. B. 58 and 59. Old Drawings.

206. A. B. (58—102.) Circulating Pump Fixtures.

207.

208. Begasse Furnace. A. Stillman.
Sugar Cooler. Martinez, Gonzales & Co. Sugar Cooler. Garr's Begasse Furnace. Perkins'.

209. Charcoal Retorts.
Porter's. McManus' Bone Black Retorts. C. H. Diamond's Retort. Tillotson's do. Perkins' do. Harris, Evans & Co's do.

210.

211. Gerricke's Turbinate Pumps.

212.

213.

214. House Heating Apparatus. Green Point School House. Stewart Brown.

215. Air Pumps.
H. 263, Air Compressors for Twin River Silver Mining Co. Brown's Air Compressors.

216.
C. 945, Hoisting Machine, 2 Drums. D. 885, do., 6 do. H. 1,195, do., 2 do. H. 471, do., 1 do. Capstan Gear, P. M. S. S. Co.

217. Allen's Car Seat.
Bucket for Mud Digger. Pile Driver. Washing Machines. R. R. Car Box, for Mississippi R. R.

218. Shop Tools, &c., Work Gearing, &c.
Plans and Lithographs of Shop. Cars for Shop R. R.

219. Oscillators. Stationary and for Hoisting and Blowing Engines.

220. "C. E." Commission Experiments.

221. Laflin's Fibre Mill. "H. M. 2," do.

222. American Air Light Co.

223. Fibre Guns.

224. Brick Machines.

225. Force and Suction Pumps.
Texidore & Brothers'. Estate St. Helena Force Pumps. Don Felix Clauzel do. Pedro Virilla Molasses Pump. Don Nicholas Plaud Liquor Pump. Ferguson's Vacuum Pump. Plan for working Pump at "Works." Aimes' Force Pump. Saiver's Lifting Pump. Dr. Rainey's Pumps. Gilbert, Moody & Secor's Pump.

226. Brick Machines.

227. Valves, Cocks, &c.
Safety Valve for Boiler of Pumping Engine, B. 1. 3, Charging Valve for Vacuum Pan. Check Valve. Do. with Brass Ball. 2, Safety Valve. 12, Vacuum Valve. Filter Valves. Screw Stop Valves. 4. 22. 3, 17. 2½, Safety Valves. 2, 7, do. 6, 27. 3, Safety Valve. 4, do. Cock for Indicator. Brass Globe Valves. 2, 11, Safety Valves. 2½, 3, do. 2½, 13, do. 4, 18, do. 2, 10, do. 4, 12, do. 7, 8, do. Double Steam Stop Valves. 4½, 25, do. 1½, 1, do. 5, 20. do. 5, 26, do. 2½, 12, do. 5½, 21, do. 1½, 3, do. 1½, 1, do. 4, 6, do. 3½, 23, do. 5, 7, do. 1½, 2, do. 2½, 15, do. 4½, 42, do. 2½, 4, do. 3½, 16, do. 2, 2, do. 3, 5, do. 2, 5, do. 2, 6, do. Steam Screw Stop Valves. 1½, 4, do. 2, 9, do.

2½, Brass Charging Valve. 3, Discharge Cocks. 4, do. Globe Oil Cock. Outboard Delivery Valve. B. 924, Galway & Caseda. 3. Safety Valve for Aimes. C. 55, Stop Valve. Arago's Feed and Blow off Valve. S. W. 1 and 2, Blow off Valves.

28. Lithographs, Prints, &c.

29. Marine Boilers, Horizontal Tubular and Flue.

A. B. 62, 65 and 66. A. B. 59. A. B. 61. Atlantic. Shop. A. B. 60. A. Morgan. Bay State. Mohawk and Yantic. Cary & Co. Revenue Boiler, &c. Cromwell's Iron Boat. Baltic. G. A. 3 and 4. G. A. I. O. 19 and 22. Alabama type, 1. Do. do. 2. Wm.. 1 G. G. Williamsburg Ferry Boat. Hermann. Santa Anna, or Edgar. Fox. Experimental Boiler. Clara Clarita.

30. Planers.

Portable. Large Planers. Planing Machine, 1. Do. I. 1 and 2. New do. Boston. English Planer, for A. Collyer & Co. Small Planing Machine. Large Turn Table Lathe Shop, 1.

31. Marine Boilers, Vertical Tubular.

G. B. 19 to 22. Arctic. Collins. San Jacinto. S. W. 1 and 2. G. B. 1 to 4. G. B. 5 to 12. G. B. 13 to 18. Atlantic. Roanoke Donkey Boiler. A. B. 17. Michigan. Gordon. Adriatic.

32. Lathes.

Havana Arsenal Lathe. Lathe A. 5. Do. Y. 9. Do. F. Do. B. 2. Do. Z. 25 and 26. Do. Y. 3 and 4. Tupper's Lathe. H. L. Strong's Lathe, A. 6. Lathe, A. 1. Large Face Lathe. Wm. Seller's Shafting Machine.

33. Marine Boilers, Flue.

A. B. 58. Shop Boiler. A. O. 1. Santa Anna. I. E. 12. Washington. Fletcher, Harrison & Co. Tatham & Brothers. S. A. Halsey. Hoadley & Street. Star of the South. Victoria. A. O. 4 and 5. I. E. 13, 14 and 15. I. E. 7, 8 and 9. Booth & Edgar. A. B. 51. S. L. 30. Southerner. Alabama. Webb or America. Columbia. Tigress. Champion of Lake Erie. Florida. Lackawana or China. General Tacon. Bazan. Kosciusko. Leon. Congress. Sabago. Sunwick. Marion or Berry. Newtown or Martha. Neptune. A. O. 1. Johnson's. Maryland Mining Co. Ash and Oak. Star and Oregon. Erie. Northerner. China. E. D. 1. A. B. 18. Meta. Ferry Co., South and Union. June. Franklin. Rimae. Achillas. Guadelquiver. N. and S. Humboldt. Four Ferry Engines. Sloan & Legget.

34. Drilling Machines and Boring Mills.

Giraffe Drill. Portable Boring Machine. Boring Table. 1. Boring Bars. Boring Bar for Cone Valve. Do. for Taper Holes. Radial Drill.

35. Boilers. Cylinder, Flue and Plain Cylinder, High Pressure.

C. 315, C. 638, C. 641, Oriatavia & Co. I. & H. Perkins. Thomas Hutchinson. Don A. Villerett. C. 26. C. 1. Jacinto Cora. Fibre Mill. H. P. Con. Rod, 14 x 48. C. 435, C. 436. A. 60, Delgard. B. 518, B. 519, Capt. Hart. Milledgeville Manufacturing Co. Wilkinson. Texidor. Burchard's. B. 10, R. S. Place. C. B. 3 and 4. E. Lind for Engine, 15 x 13. R. Hoe & Co. B. F. 2, DeForrest. C. A. Fernandez. Peter Cooper. R. H. Steel's. F. D. 1. Hunt's Saw Mill. B. 638, E. Gaudelet. Richardson. Kettridge. Perkins. Engine B. 10. DeForrest & Co. Opperheimer's. G. B. Nichols. Brice. F. D. C. Boiler. Don Jacinto Cora. C. B. 4 and 5. Robert Stevens. DeForrest & Hodge. New York and Erie Railroad Co. Nile Pumping Engine. E. 20. Thompsonville Carpet Co. Luther & Mason. Yznaga's Engine. A. Coit. Benedict & Burnham. American Bible Society. Tracey's. Hazard Powder Co. H. P. 28. D. F. Tiernan. Stienway & Son. Delogney's. J. Jewell & Son, Engine 20 x 4, 2. Sanchez. G. H. Delacroix. Schlessinger. Royal Arsenal, Havana. Don Simon Arrechea. Don Carlos Malibran. G. B. Lamar. Scull & Manuel.

236. Bolt and Screw Machine.
Key Grooving do. Slotting do. Place's new Screw Cutting do. Bolt do., 5. Hodge's Screw Cutting do. Screw do., 7. Small Crank Slotting do. Pillar do. Key Grooving do.

237. Boilers, Locomotive. Vertical Tubular and Donkey.
A. B. 60, 61, 62, 65, 66, 92 and 93, Donkey Boilers. A. B. 58, Donkey Boilers. Rio. Pacific Mail Donkey Boilers. Cypress. S. L. 31, Donkey Boiler. S. L. 3, do Berry. do. N. and S., do. Asa Fitch. Hydraulic Eng., H. 2 or Y. 6 and 7. Parsons & Co. Platner & Smith. Bird's. Bathing Co. N. D. or C. E. Boiler. J. W. Wallace. Baldwin's. Lowber & Leroy. Gwynn. Ribon Boiler. Gale & Co. Stoddard & Dunham. C. K. Diamond & Co. Siam Engine, 2 and 3. Boiler Shop Boiler. Johnson & Brother's. Osgood's Boiler.

238. Punches.
Gooseneck Punching Machine. R. R. Punch, for Raleigh and Gaston R. R. Co. Screw Punch. Fly Punch. Boiler Shop Punch. Hand Punches, for Havana Arsenal. Double Acting Punching Machine. Screw Punch, for Coppershop. Hydraulic Punching Machine.

239. Boiler, Horizontal, Cylinder, Tubular.
Ranson. I. & B. Johnson. A. O. 4 and 5, Pumping Engine Boiler. Engine. Y. 9 and 10. Manhattan Gas Co. Royal Arsenal. Tillotson. House of Refuge. 7 H. P. Boiler. 6 H. P. do. Hiscox. Hermann, Donkey Boiler. Baltic, do. Collins. G. A. Donkey Boiler. Stedman. James M. Shaw. Watermire & Breman. Bowery Savings Bank. Locomotive Boiler, 1. Do. 2. Funneling Machine. Mackert's Lock Factory. R. M. Stratton. Pacific Mail S. S. Co. B. 819. Habana R. R. Atlantic's Pumping Boiler. Domingo's. Crane Boiler. Russia's Donkey Boiler. C. 684. John A. Moore. Dr. Herigronet's.

240. Mabbett's Railroad Chair Punch. Boiler Shop Table Punch.

241. Boiler Fixtures. H. P. Stationary.

242. Boiler Shop Tools.
Riveting Machine. Shears. Plate Bending Machine. Do. do. for Havana Arsenal. Shearing Machine.

243. Boiler Fixtures. Marine.

244. Boiler Shop Tools.
Hand Boiler Shears. Shackles. Pall Wrenches. Socket Machine. Rotary Shears. Adjustable Hook. Flange Clamps. Bending Blocks. Cramps.

245. Copied Drawings.
A. B. 62, 65 and 66, Chauncey, Montana. Arizona. A. B. 61, Colorado. Atlantic. A. B. 58, Constitution. Tobago. Tatham Brothers. Williamsburg. Fanny. Southerner. A. B. 58, Donkey. G. A. Palmetto. A. B. 17, Metropolis. Victoria. Four Ferry Boats. Shark. Boston. Peru. H. D. 63 and 64. Erie. A. O. 1, Augusta. Nashville. Berry or Marion. Achilles. Russia. Columbia. Crane Boiler. H. D. 63 and 64, Donkey. Bay State. Alabama. R. R. Co. Single Propeller Engines. China. Kosciusko. Star and Oregon. Northerner. Columbia. Ribbon. Cromwell's. Fletcher. Harrison & Co. A. O. 4 and 5, Arago. I. O. 19 and 22, Ashuelot, Pawtuxet. Rimac. Cherokee and Tennessee, or Ash and Oak. Michigan. Newtown. G. A. Side Wheel Gun Boats. S. W. 1 and 2, Adirondack. Shop Boiler. E. H. Simpson. Leon. Ed. Gaudelet. A. B. 56 and 57, City of Boston, City of New York. A. B. 59, Golden City. Union. Maryland Mining Co. June. Neptune. A. B. 67, Newport. Hermann. Crane Boiler. Alabama. I. E. 13, 14 and 15. A. B. 51, Long Island. Tobago. Florida. A. Morgan, Georgetown, S. C. A. B. 59, 60, 61, 62, 65 and 66, Donkey Boilers. Tigress. Santa Anna or Edgar. Champion of Lake Erie. Franklin. Star of the South. Florida.

SECOND SERIES.

1. O'Donnell's Saw Mill. Williamson, Munn & Co's Cocoa Crusher. Steamer Eagle. Plate Bending Machine for Boiler Shop. Trotter & Stillwell's Pillow Block. Experimental Account. Northener's Beam. Drying Cylinder. Empire's Air Pump and Reservoir.

2. Steamer June. Seller's Hammer (old details). Loubat's Girders. South Carolina. Connecting Rods for S. M. Dodge.

3. Steamer Newport. Manhattan Gas Co's Hoisting Apparatus. Connecting Rod, Steamboat Fox.

4. Washington (old drawings). Palmetto's Beam. Steamer Oliaba's Bracing for Thrust Bearing.

5. Seller's Hammer. Steamers Southerner, China, Philadelphia and Chesapeake. Ribbon Winding Machines. Washer Gate.

6. Hydraulic Testing Machines for Pipes. Exhibition Building, Crystal Palace.

7. Benton, Crook & Co's Blowing Cylinder. Foundry Machinery. Drying Cylinder for H. V. Butler.

8. Steamer Philadelphia's Cut-off. Howland & Moller. Bolts, &c., for Cattle Mill, B. Steamer Massachusetts.

9. Coal Trucks for Steamers and Sugar Houses. Tillotson's Retorts. Dr. Rainey's Timber Baths. Silver's Governor for Propeller Caledonia.

10. Shafting and Pump for Manhattan Gas Co. Valves, &c., for Freeman Rawdon. Steamer Arabia's Out-board Bearing. Steam Air Pump.

11. Repairs to Engine of Henrietta Estate. Stand and Bolster for Star Shafting, Tucker & Cooper. Sole Plate for Star Shafting, Tucker & Cooper. Slabbing Machine, Carhart & Needham.

12. Steamer June. Blowing Cylinders.

13. Animal Black Machine. Reefing Paddle Wheel.

14. Animal Black Machine. Southerner's Water Wheel. Claghorn & Cunningham. E. Sawer & Co., work for.

15. Steamer Leon. Lafayette, Bracing for Cylinder Slides.

16. Cook & Caldwell's Cotton Machinery. Hangers for Star Shafting. Virginia Copper Ore Dressing Co. Washington's Cut-off.

17. O'Donnell's Marble Machinery. Atlantic's Extra Fixing. Condenser for Steamer Empire.

18. Blowing Engine, Congress. Valve Gear. Experimental Account. Sluice of the Florid Dock, Havre.

19. Steamer Cornet, details Levivel's Crane. Steamer Congress' Crosshead. Circular Dies for Annihilator.

20. Steamer Alleghany's Slide Valve. Gearings for Ferry Bridges. Dr. Rainey's Pile Cutter. Steamer South Carolina. Girders for A. M. Lawrence.

21. Engine, D, No. 7. Winfield's Screw. Steamer Philadelphia. Rolling Machine for Corrugated Plates.

22. Manhattan Gas Co. Lapice's Turn Table. Morten & Brenier. Logwood Mill, Luther & Mason.

23. Locomotive Cut-off. Beam for Pumping Engine, C, No. 1. Manhattan Gas Work Apparatus. Porter's Steam Pipes. Raub's Double Acting Safety Valves. Ester & Co's Spur Wheels.

24. Miscellaneous Drawings of Cranes by H. Allen & Burnett. Steamer Erie. Wheeler, work for. Quimby's Steam Whistle.

25. R. S. Turnbell, Shafting, &c. Washington's Cut-off. Adjustable Cut-off. Sea Gull, Pipes.

26. Goodell's Blowing Cylinder. Steamer Star. Atlantic's Register. Cranes. Heater for Steamer Trinidad. Work for R. S. Stevens. Piston Rod for Tupper.

27. Palmetto's Cut-off. Tigress. Foundry Machinery. Lord's Safe. Coffee Mill. Cattle Mill for Cardose.

28. Zephyr's Cut-off. Valve Chamber for Steamer Unicorn. S. N. Dodge. Engine Repairs.

29. Lyman's Meat Car. Begasse Arrangement. Poppet Valves for Steamer Massachusetts. Powhattan.

30. Paper Mill. Steamer Osprey, British and West India Mail Steamer. Cook & Caldwell's Cutter. Barnes' Wheel Arrangement. Shafting for Smith and Boiler Shops. Shaft for Cattle Mill, Rattan Estate. Design of Fly Wheel.

31. Cattle Mill, C, 18 by 22. Johnson's work. Clasp Coupling, Jackson. Coupling for Shafting, Smith Shop. Tillotson's Pipes. Shaft for Steamer Gen. Pierce. Cook & Caldwell, Cotton Machinery. Holt & Owen, Cattle Mill. Mud Machine.

32. Stevenson's Engine. Kerosene Gas Apparatus.

33. Side Frame for Locomotive. Jones' Planer.

34. Foundry Cranes.

35. Mallory's Experiments. Sugar Arrangements. Kerosene Gas Works. Philadelphia's Crank Pin.

36. Congress, Blowing Engines. Wall Drilling Machine for Boiler Shop. Logwood Mill.

37. Circassia's Propeller. Vacuum Pan, X, No. 1, Connections. Glass Grinding Machine.

38. Stamper's Amalgamaters, &c. Steamer Lavosier, repairs.

39. Engine Register. French Gas Engine. Fitch's Water Wheel. Ferguson's Pan and Pumps. Vacuum Pan, Aimes & White. Diving Bell.

40. Steam Air Pump, No. 1. Boiler Shop Drilling Machine. P. T. Barnum's Drop Press.

41. Porter's Saw Mill. Naverte's Boiler Fixtures.

42. Scott's Sketches for Briningier's Clarifiers. Johnson's Boiler Fixtures. DeForrest's Sugar House. Forsythe & Simpson's Engine Repairs.

43. Aimes' Pumps. Tracy's Old Engine. Tillotson's Boiler Fixtures. Day Register Fixtures.

44. Porter's Grist Mills. New York Dyeing and Printing Co. Lapia's Cutter. Steamer Lake Erie's Crank.

45. Anderson & Co's Boring Bar. Sugar Mill Details (old drawings). Palmer's Boiler. Cook's Blowers.

46. Scale Drawings of Saw Mills. Fish Presses, &c. Nile's Dredging Machine.

47. Potter's Cut-off. Steamer Golden Age, Surface Condenser. Pipes, &c., for Sugar Arrangements. Vacuum Pan, X, No. 1.

48. Lathe, Z. Alberti & Co's Swedge Block.

49. Forientee & Brothers. Pease & Murphy, Cylinder Head. Sloan & Leggett Cylinder Head. Rawdon's Pistons.

0. Sterling's Saw Mill. Belts, &c. New Orleans Gasometer. Fitch's Water Wheel.

1. Brass Lifting Pump. Washington's Pumping Engine.

2. Slotting Machines. Steam Gauges. Shot Furnace. Drop Press. Tieman's Extractor. Tracy's Old Engine. Pipes for Sugar Arrangements.

3. Hydraulic Press for Metallic Life Boat Co. Croton Water Fixture. Brevort's Saw Mill.

4. Hamilton's Saw Mill. Sheldon's Lifting Pump.

5. Davison's Saw Mill. Old New Orleans Pumping Engine. Tiger, Pumps. Lyman's Heater.

6. Arago's Tanks. Crane for Copper Shop.

7. Ships' Railings. French Engine Sugar Mill Arrangement. Allen's Car Seat.

8. Pumps, Rotary, Lifting and Force. Davison's Plan for Steam Chest. Perkins' Work. Boston Press.

9. Oscillator, A, No. 1. Shaft for Sugar Mills. Crane for Copper Shop.

0. Pipes for Sugar Arrangements. Francis' Metallic Life Boat Co. Tuckerman's Pumps. Lapice's Vacuum Pan. Stove for Heating 24th Shop.

1. Gasometer in 14th Street. Sugar Arrangements (old detail drawings). Pump for Brooklyn Sugar Refinery. Stewart's Pumps.

2. H. M'Call's Air Pump. Steamer Merlin. Blowing Engine. Davison's Compound Rail Chair.

3. Hamilton's Saw Mill. Pumping Engine (old drawings). Sugar work for Fernandy. Brass Hand Pump.

4. Crane for Copper Shop. H. V. Butler's Washing Machine. Pile Drawer.

5. Cook's Retort. Stillman's Safety Fuse. Perry's Gas Engine. Merrick & Town's Sugar Crusher. Stewart's Sugar Crusher. Shafting for Osgood's Sugar Cutter.

6. Sturge's Crusher. Water Elevator for Henrietta Estate. Boston Blowing Engine. Oscillator, A, No. 1.

7. Sugar Mill, S, No. 1. Diving Bell. Vacuum Pan.

8. French Gas Machine. Vacuum Pan, V. Aimes. Saw Mill. Kitridge's Pumping Engine.

9. Clarifiers. Pipes, &c. Engine, D, No. 15 and 16. Pipes for Sugar Arrangements.

0. Berdan's Oven.

1. Tupper & Lee, Turning Machine. Lake Propeller Engine, No. 1 and 2.

2. Coal Car. Submarine Excavator.

3. Allen's Quartz Washing Machine. Barley's Dovetailing Machine. Engine Register Fixtures for City Water Works. Tracings of New Orleans Pumping Engine.

4. Bisulphate Experiments. Punching and Riveting Machine. Hozen's Amalgamater.

5. English Cranes. Willoughby's Cart. Ship Railing. Gilmour's Patent Chain Stopper. Tilt Hammer for Welding Steel.

6. New York Belt and Packing Co. Leaf Filter for Dr. Henry. Steam Sluch.

7. Hutchinson's Excavators. Baird's Engine. Monstrom's Steam Wheel.

8. Light House. Buoy for Pacific Mail Co. (old).

79. 5 Horse Engine. Mitchell's Pile Driver. Engine and Arrangements of Sugar Mill. Pipes for 10 Horse Engine.

80. Loam Mill. Wilkinson's Air Pump for Press.

81. Sugar Mill Details (old drawings). Solomont's Amalgamater and Fixtures. Mortise Wheel. Sugar Mill and Arrangements. Turning Machine.

82. Sugar Arrangements. Davison's Hoisting Engine. Oscillator, 6 by 12. Plans of Mill Work, Floor, &c.

83. Plan of Cradle. Suydam's Alterations of Steam Engine. Saline's Screw Machine. Roller Bearers.

84. Mortar.—Reynold's Plow. Punching Machine, Tucker. Undershot Wheel. —Windmill. Oscillating Cylinder, 36 by 42½.

85. Berdan's Oven.

86. Lyman's Accelerating Gun, &c. Davidson's Car Brake. Crocker's Elliptic Wheel. Apparatus for Testing Wrought Iron Bars. Slide Valve, C, 306, Standard Brasses. D, 461, Small Cannon.

87. Fell & Wychoff's Caloric Amalgamater. Finishing Tool for Steam Engine, Column for Planisher. Gilmour's Patent Chain Stopper and Sheave Blocks. Buoys.—½ Ton Coal Tub.—Ship's Drag. } Pacific Mail Co.
Capstan Heads.—Round Grate Bars. }

88. Geared Fly Wheel, &c., for Kochler & Kupper. Read & Bro's Brewery Work. —Crank Shaft, Mississippi. B, 973, Soda Water Machine.—D, 668, Diving Bell. D, 693, Tank for Rail Road & Machinery Oil Co. B, 478, Pile Cutter. Plan of Rolling Mill. Overshot Water Wheel. Work for J. M. Eggert of Peru. Allen's Wooden Thimble Cutter.

89. Railroad Frogs and Points. F, 327, Soap Mixing Apparatus. D, 852, Cylinder for Sitka Marble Co. F, 58, 2 Guns and Carriages for Yacht Josephine.

90. L. L. Todd, Cast Iron Tank, 12 by 36. American Hat Machine. F, 15, Horse Power and Pump Connections.

91. Salt and Fresh Water Fixtures for Novelty Iron Works. Shop A, Pump and Boiler Shop Pipe and Tank.

92. F, 881, G, 197, Fletcher's Patent Grate Bars.

93. Brown Paper Sketches of Burr's Cotton Press.

SEVENTH

ANNUAL REPORT

OF THE

Sheffield Scientific School

OF

YALE COLLEGE.

1871–2.

PRINTED BY ORDER OF THE GENERAL ASSEMBLY.

NEW HAVEN:
TUTTLE, MOREHOUSE & TAYLOR, PRINTERS.
1872.

Special Articles contained in the previous Annual Reports.

1. 1866. Historical Statement.
2. 1867. Description of Sheffield Hall.
3. 1868. Aim and Object of Scientific Education.
4. 1869. Preliminary Roll of Benefactors, Officers and Students, 1846–69.
5. 1870. Catalogue of the Hillhouse Mathematical Library.
6. 1871. Catalogue of the Drawings received from the Novelty Iron Works.

REPORT OF THE STATE BOARD OF VISITORS.

the Senate and House of Representatives in General Assembly convened:

THE State Board of Visitors of the Sheffield Scientific hool respectfully report that they have twice visited this ıtitution within the past year, and have otherwise kept themves acquainted with its progress. At the anniversary in ly, twenty-six young men were graduated, a selection of ir theses being publicly read in the presence of this Board. e usual appointments to the State Scholarships were also le. At the semi-annual meeting on the 22d of February, a ıber of the former State Visitors, and of the benefactors, mpanied the Board on a visit to the various departments ıe school, and listened to the statements of the officers in ct to the condition and prospects of the institution. These ıents will be substantially appended to this report as a n thereof.

Board refer with pleasure to the increasing prosperity of ıeffield School. It has never had so large a number of s, so many members of the Freshman class or so many ıduate students, as during the year now current. The of scholars of all classes is one hundred and forty-nine. s are also gradually increasing, and although the salaries he instructors are still most inadequate, the number of s, the books, apparatus, and collections are increasing, :hool is establishing itself so thoroughly in the favor of unity that its proper endowment must certainly come.

The generous citizens of this and other States may well turn their benefactions to an institution where so much is done with the means at command. A full report of the donations already received is given herewith.

One generous gift, from a lady, born in this country, but long resident in England, surpassing in amount the gift of every other benefactor but one, deserves especial gratitude. Mrs. ROBERT HIGGIN, of Liverpool, has given five thousand pounds sterling for the chair of Dynamic or Mechanical Engineering,—a chair, the instructions of which are intimately allied to the manufacturing industries of Southern New England.

Mr. JOSEPH E. SHEFFIELD, of New Haven, in addition to his large gifts of money, has also commenced the erection of a new building for the use of the school, a more particular account of which is deferred to next year.

The Board have also heard with gratification of the generous gift of Hon. O. F. WINCHESTER of New Haven, by which an Observatory, for astronomical and physical researches, will presently be established at New Haven, in connection with Yale College, the advantages of which will of course be shared by the Sheffield Scientific School.

The proposal which has been made in the United States Senate to bestow a second grant of land on this and the allied "State Colleges of Agriculture and the Mechanic Arts" in the different States of the Union, deserves the hearty encouragement of the citizens of Connecticut.

The people of this State cannot show in too many ways, or too soon, their appreciation of an institution which is closely connected with the material welfare of the State, and which is also adding to the intellectual culture of Connecticut, and to its reputation throughout the land. The young men and boys of the State, as well as parents and teachers, should also consider more fully than they have yet done the new professions

which are opening in these days, and the opportunities which are offered by the Sheffield School in preparation for such callings.

In behalf of the Board,

MARSHALL JEWELL,

Chairman.

BIRDSEY G. NORTHROP,

Secretary of the State Board of Education.

NEW HAVEN, MAY, 1872.

ANNUAL STATEMENT

OF THE

GOVERNING BOARD.

THE Governing Board of the Sheffield Scientific School present their Seventh Annual Report to the State Board of Visitors, and through them to the public, with more encouragement than ever. The manifestations of public confidence and support have never before been as manifold or as gratifying as in the year just closed.

Additions to the Endowment.

The effort which began in 1870 to raise a fund of a quarter of a million dollars for the further endowment of this institution has been successful, and that amount is secured. The Governing Board congratulate themselves and the public on this auspicious result; and they return their heartiest acknowledgments to all who have aided in any way this undertaking. It is gratifying to remember that nearly all the subscriptions which have been received have been offered to the Board without any personal urgency. No agents have been employed, and no commissions have been paid. A variety of private and public meetings have been held; a number of explanatory pamphlets have been printed; gentlemen at home and from a distance have been induced to visit and examine the school; in short, it has been the constant endeavor of the Governing Board to interest intelligent men in the character, the results, and the methods of the work in which we are engaged. We have especially endeavored to bring our friends into a true acquaintance with the spirit which animates the institution, and to an exact understanding of the uses to which the money here bestowed will be directed. We have also endeavored to show how much the promotion of scientific education may do for the welfare of the country, and how inviting are the callings which are open to young men who are trained in the principles of scientific investigation. In disseminating these views, we have been *admirably* aided by the editors of the leading journals in this State *and New* York, many of whom, without any suggestion from us,

have discussed these questions, and the relations of our work thereto, in a very serviceable manner.

Many of the subscriptions we have received have been payable at once in cash; a few are in the form of notes, the interest of which is annually due until the principal shall be paid at the convenience of the subscriber; some are intended as a part of the funded endowment; others are designed as subscriptions toward current expenses; most of the subscribers have left their donations unlimited in respect to the special purpose to which they should be directed; two of the donors have designated important departments of study which they preferred to encourage.

As one after another our friends have come forward in person, or by letter, and have stated what they proposed to do, we have felt new courage in this undertaking, and new determination to labor with our utmost strength to promote the trust committed to our charge. It has been especially gratifying that the citizens of New Haven, and that among them those who were most familiar with our endeavors, have responded so liberally. Twenty-six of the citizens of New Haven have each given to the school sums of five hundred dollars and upward. From residents of New York city we have received nearly twenty-five thousand dollars—not including the priceless gift of drawings from the Novelty Iron Works.

The list of the subscriptions of money since Commencement, 1869, is as follows:

Subscriptions to the Endowment since the publication of the Fourth Annual Report (1869).

Joseph E. Sheffield, New Haven, (additional,)	$76,000
Mrs. Susan K. Higgin, Liverpool, Eng.,	£5.000=$28,000
William Walter Phelps, New York,	10,000
A Friend,	5,000
William W. Boardman, New Haven,	5,000
Richard S. Fellowes, New Haven,	5,000
Joseph Sampson, New York, (additional,)	5,000
William E. Dodge, New York,	3,000
James E. English, New Haven, (additional,)*	1,000
Henry Bronson, New Haven, (for Comparative Anatomy and Zoölogy,)	1,000
William Howe Downes, (by Dr. John I. Howe,) Birmingham, Conn.,	1,000
Samuel Holmes, New York, (scholarship,)	1,000
Henry Hotchkiss, New Haven,	1,000
Tredwell Ketcham, New York	1,000

* A further subscription of $3,000, for income, is acknowledged beyond.

William B. Ogden, New York, (land,)	$1,000
James M. Townsend, New Haven,	1,000
Ezekiel H. Trowbridge, New Haven,	1,000
Henry Trowbridge, New Haven,	1,000
Thomas R. Trowbridge, New Haven,	1,000
Robert Benner, Astoria, N. Y.,	500
Eli W. Blake, New Haven,	500
Jarvis Brush, New Haven,	500
Joshua Coit, New Haven,	500
Henry A. DuBois, New Haven,	500
Marshall Jewell, Hartford,	500
Harmanus M. Welch, New Haven,	500
Timothy Dwight, New Haven,	300

Foundation of the Higgin Professorship.—Among these gifts received within the year is that of Mrs. SUSAN K. HIGGIN, widow of the late Robert Higgin, Esq., of Liverpool, England, who has endowed the professorship of Dynamic Engineering held by Professor Trowbridge with a foundation of £5,000, which has yielded the capital of $28,000.

This munificent gift from an American lady resident in a foreign country, and still deeply interested in the prosperity of her native land, is one of the largest and most gratifying contributions the School has ever received. It was made during the visit of Mrs. Higgin to New Haven in the summer of 1871, when she had the opportunity of looking into the plan and the results of the institution she has so greatly aided.

Construction of a new Building.—Mr. JOSEPH E. SHEFFIELD, in consideration of the interest which the public has shown in the School, and of its rapidly increasing importance, has added largely to his previous gifts in money, and has begun the erection of a second building for the use of the School. It will stand upon Prospect street, north of the present edifice, and will be devoted to lecture-rooms, class-rooms, and collections. A detailed account of its plan and of the purposes to which the structure is devoted will be given next year. Its estimated cost, aside from the land on which it stands, is not far from $100,000, and this sum is included in the aggregate amount of subscriptions which is mentioned above. This new act of munificence will greatly improve the condition of the School, and will enable the Board to direct all the other contributions of our friends to the improvement of the inside work of the School, the instruction of young men. Already, with our increasing classes, the present building is quite too small, and several of the departments of instruction have no place within it.

Contributions to the Income of the School.—Some of the most generous gifts which we have received have been for the payment of the current expenses. Such donations are made in the belief that, as the School becomes better known, its permanent endowment will be increased by gifts and legacies; and that for the present it is very important to keep up its character, enlarge its corps of instructors, and increase the attractions to young men of talent and ability to pursue its instructions. Hon. JAMES E. ENGLISH, who, as Governor of the State, has been officially made acquainted with all the affairs of the School, in addition to other gifts, has subscribed for three years the sum of $1,000 annually. The full list of such subscriptions is as follows:

Subscriptions to Income made during the last two years.

James E. English, New Haven, $1,000 annually for 3 years,	$3,000.00
A Friend,	2,000.00
Edward A. Mitchell, New Haven, $250 annually for 10 years,	2,500.00
John D. Wheeler, New Haven, $300 annually for 5 years,	1,500.00
Frederick H. North, New Britain, $300 annually for 5 years,	1,500.00
Colin M. Ingersoll, New Haven, $60 for 5 years,	300.00
Jeremiah A. Bishop, New Haven, " "	300.00
Matthew G. Elliot, New Haven, $50 "	250.00
Edward S. Scranton, New Haven,	250.00
Benjamin Douglas, Middletown,	100.00
Henry Stanley, New Britain,	100.00
Isaac Thomson, New Haven, $50 for 2 years,	100.00
James D. Dana, New Haven,	80.00
William Gamble, New Haven,	50.00
Perkins & Chatfield, New Haven, amount of bill,	83.82

Gifts for Special Purposes.

Joseph E. Sheffield, New Haven, (for Hillhouse Library,)	$4,000.00
William Johnson, New Haven, (for maps,)	500.00
William Hillhouse, New Haven, (for library),	500.00
Class of 1869 (not yet designated,)	210.00
Class of 1870 (not yet designated),	140.00
Prizes from several gentlemen,	315.00

A summary of all the benefactions in money since the School began will be found appended to this statement.

An Appeal for still further Aid.

Those who are at all familiar with the prospects of scientific education in this country must clearly see that, notwithstanding

these generous gifts, the School stands greatly in need of further funds, for the employment of teachers, and the purchase of all requisite materials. Every year makes new demands upon its capacity. The present Freshman class, for example, is so large that it is divided into sections for all its lessons, and an extra force of teachers is thus rendered necessary. New departments of study are added also from time to time. The general labor of administration is moreover much increased. Besides all this Science is advancing in every direction, and men who are skilled in every specialty are needed as instructors. Other like institutions, richly endowed, are springing up all over the country. Our tuition is comparatively high, and funds for the aid of deserving young men are greatly needed. We feel that a beginning only has been made in the work of scientific education; what the future may afford depends largely upon the continuance of private favor and generosity, which have been so helpful in the past.

Proposed "Professors' Fund."

In this connection attention may be called to the following proposal. At the meeting of the Councillors of the School held at Commencement, a communication was received from a gentleman who insisted upon concealing his name, offering $10,000 toward a professors' fund of $50,000, provided that amount should be raised within two years. A second offer of a like sum was subsequently made by another gentleman who concealed his name, and accompanied his promise with a check for five thousand dollars. The Governing Board are very desirous of securing this amount in the course of the present summer, and subscriptions for this purpose will be most welcome. It will be noticed that to secure $20,000 already offered $30,000 more is requisite. The offer expires in 1873.

Foundation of the Winchester Observatory.

The Sheffield Scientific School, as well as the other departments of Yale College, will ultimately share in another munificent gift for the promotion of science, which has been made within the year by another citizen of New Haven. Hon. O. F. Winchester has purchased from Mrs. James A. Hillhouse and her daughters a tract of 32 acres upon Sachem's Ridge, and to this has been added, by the consent of the College Corporation and at the request of *Mrs. Hillhouse* and her daughters, an adjacent tract of 6 acres

which they had previously given for an observatory. The entire tract has been surveyed, and will be improved and divided into villa lots, from the sale of which a fund is to be derived for the foundation of an observatory for astronomical and physical researches. This will add another to the group of institutions which will constitute the University in New Haven.

Remembrance of Deceased Benefactors.

Three of the benefactors of the School have died within the year. Hon. Wm. W. Boardman of New Haven, a graduate of Yale College in the class of 1812, who has held a great variety of public trusts in the State of Connecticut, died in New Haven, August 27th, 1871. He was one of the earliest persons who showed an interest in this department of the College, having presided at the meeting of citizens of New Haven, held May 19, 1856, to consider this subject, and having been for this reason again selected to preside at the meeting of citizens held November 10, 1870, to hear a statement of the results of fourteen years' progress. He contributed to the formation of the scientific library and of the natural history collections, and not long before his death made the generous gift of five thousand dollars to the permanent fund.

Henry Hotchkiss, Esq., President of the New Haven County Bank, and subsequently a prominent manufacturer, became interested in the School within a short time past; and when the recent endowment subscription was begun, he was one of the first to subscribe the sum of $1,000, and to express his willingness to increase this gift at some future time. He died in New Haven, early in 1872.

While the Report is passing through the press, the death of Joseph Sampson, Esq., of New York, another of our benefactors, is announced.

Mr. Sampson was a prosperous merchant in New York, who was accustomed to spend a part of every summer in New Haven, and thus became personally familiar with the work of the Sheffield Scientific School. In every new emergency the Governing Board were sure of his sympathy and assistance. He contributed five hundred dollars to the formation of the Scientific library, then one thousand dollars to the general fund, and again five thousand dollars to the general fund. Still more recently he purchased for the College Cabinet of Mineralogy the Blum collection of Pseudomorphs (referred to in the last report of the school), at a cost of three thousand dollars. All these gifts were made with great cheerful-

ness, and with characteristic unostentation. His gifts to the other departments of the college were likewise frequent and liberal, amounting in all to many thousand dollars. His death occurred in New York, May 21, 1872.

National Aid to Schools of Science and Technology.

This institution, in common with many others of kindred character in different parts of the country, owes its present position largely to the land grant bestowed by Congress in the enactment of July 2, 1862. From this source a fund of $135,000 was received, but this was only one result of the grant. Its bestowal secured the maintenance of this School, strengthened the confidence of the instructors and the public, and elicited the generous contributions of many individuals in Connecticut and at a distance. Every year gives new evidence of the wisdom of the Congressional enactment which secured (*a*) local responsibility under national aid; (*b*) scientific education without the disparagement of literary culture; (*c*) scientific schools rather than simple agricultural schools; and (*d*) instruction funds instead of bricks and mortar.

Under these circumstances, the Board could not fail to notice with profound interest the recent determination of the National House of Representatives to devote the proceeds of the public lands to the promotion of education; and almost simultaneously, the introduction of a bill in the Senate proposing to bestow upon the several institutions, aided by the enactment of July 2, 1862, an additional grant of land. The author of the bill now pending in the Senate, Hon. Justin S. Morrill of Vermont, was also the leader of the movement in the House which secured the grant of ten years ago. By his invitation, and also by invitation of Hon. W. A. Buckingham of Connecticut, who has been familar from the beginning with the history of the endowment in this State, a committee of the Governing Board of the Sheffield Scientific School addressed two private assemblies of Senators and Representatives in Washington on the 17th and 18th of April, with reference to the importance of these scientific and polytechnic institutions.

Two meetings held within the year have quickened the public interest in this subject.

Chicago Meeting of Friends of Agricultural Schools.

A gathering of gentlemen interested in Agricultural Schools was held in Chicago, August 24, 1871, for the purpose of conference and discussion in respect to the best method of promoting agricultural knowledge and education, and still more particularly with reference to the experiments in agriculture which may be made by the various institutions of this class. The Western States were well represented at this meeting, and the exchange of opinions and sentiments was not only valuable in itself, but serviceable as an introduction to the larger conference which was subsequently held in Washington. Dr. J. M. Gregory was the President of the Chicago meeting; Professors Prentiss and Hamilton were the Secretaries. The Sheffield Scientific School was represented by the Secretary.

Agricultural Convention in Washington.

By invitation of the Commissioner of Agriculture a convention of delegates from agricultural societies, and from institutions of learning connected with the promotion of agriculture, was held in Washington, at the Agricultural Bureau, on the fifteenth day of February last. The delegates from Connecticut were Hon. E. H. Hyde, lately President of the State Agricultural Society, and one of the State Board of Visitors of this institution, Theodore S. Gold, Esq., Secretary of the State Board of Agriculture, J. I. Allen, Esq., of Windsor, Prof. S. W. Johnson and Prof. D. C. Gilman of the Sheffield Scientific School. Dr. Geo. B. Loring, of Massachusetts, presided.

More than one hundred delegates, representing most of the States in the Union, were in attendance, and the exchange of opinions on topics pertaining to agriculture and to technical education was of value. The most important subjects which were considered at the suggestion of the business committee were four: (1) the desirability of asking from Congress a further appropriation for encouragement of technical education; (2) military instruction in the colleges of agriculture and the mechanic arts; (3) the establishment of agricultural experiment stations; and (4) the best mode of coöperating with the Department of Agriculture.

On the second and fourth subjects no definite conclusions were reached. After a discussion of the third, a committee was appointed to consider and report what measures should be recommended. Prof. S. W. Johnson, by a special vote of the Conven-

tion, was requested to draw up a report, including in it an investigation of the workings of experimental stations in Europe, and an inquiry as to the establishment of like experimental stations in this country.

As a result of the discussion of the first topic a committee was designated and requested to memoralize Congress in favor of an increased appropriation. Most of the members of the committee remained in Washington after the convention adjourned, drew up the proposed memorial, presented it to Congress, and made the proper explanations before the committee to which it was referred.

Additions to the corps of Professors.

In consequence of the increased funds of the school, two new professors were appointed at the last commencement. Mr. Thomas R. Lounsbury of Ovid, N. Y., who graduated as Bachelor of Arts in Yale College, in the class of 1859, was invited to become Professor of English, and Mr. Oscar D. Allen, Ph. Dr., of Hebron, Me., who graduated in the Sheffield Scientific School in the class of 1861, was invited to be Professor of Metallurgy. Both these gentlemen had been for some time previous instructors here in their specialties. Mr. Lounsbury has spent much of his time since he graduated in the study of Anglo-Saxon and Early English, and in the critical perusal of English authors. His accession has enabled the Governing Board to recast the literary studies, to provide for the study of English in a much more thorough degree, and to exact more exercises in composition. Mr. Allen, in addition to his studies in the Sheffield laboratory, has studied abroad, and has been successfully engaged in actual metallurgical work in Pennsylvania.

Instruction in Drawing.

One of the most noteworthy changes of the year has been the increased attention to Drawing. Mr. John H. Niemeyer, having been appointed, after several years of study in the *École des Beaux Arts* in Paris, to be the Professor of Drawing in the Yale School of the Fine Arts, arrangements were made by which the Freshmen of the Scientific School received his instructions. During the first and second terms, four mornings a week were devoted to the class, meeting in two sections, and they were taught free hand drawing. A beginning was made in drawing from the

flat, portions of the human figure, and as the scholars attained proficiency in the use of the pencil, they began to draw from casts and other objects. At the close of the winter's work, the drawings of all the class were publicly exhibited, showing the exact proficiency of each person from his first to his closing lesson. A lecture on the result of the work was publicly given by Prof. Niemeyer in the presence of the officers and students of the Scientific School and a few invited guests. The exercise of the third term under Mr. Niemeyer's direction is practice in sketching the outlines of the landscape.

A similar degree of progress has been made in instrumental drawing. Mr. F. R. Honey, formerly a pupil of the South Kensington School in London, and subsequently a practical Mechanical Engineer, has commenced the instruction of our Freshman class in the elements of Orthographic projection according to the well known system of Binns; and he has been assisted in these lessons by two of the recent graduates of the school, Messrs. Klein and Mather. The previous practice in free hand drawing prepared the class for this instrumental work, in which they are doing well, and this in its turn is preparing the way for the professional drawing of the engineer and the architect. The class in Mechanical Engineering has also received Mr. Honey's instructions.

The Governing Board feel much gratified by the enthusiasm awakened by both these teachers, and by the results which have been attained by most of the Freshmen class.

Instruction in the Use of the Plane Table.

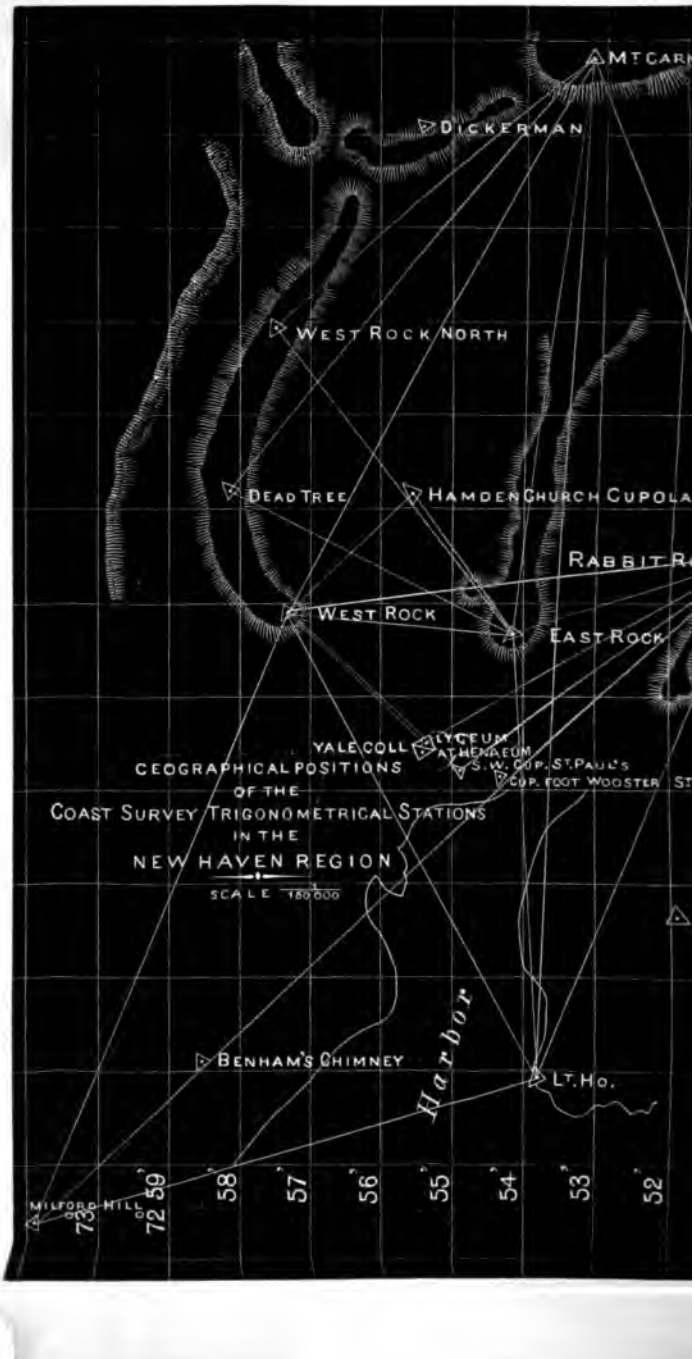
Prof. PEIRCE, Superintendent of the Coast Survey, having in August last detailed Mr. Richard Meade Bache, Assistant, to make a survey of the New Haven Region, north of the city, the work was begun and prosecuted late into the autumn, leaving between that time and the opening of the next season's operations, in the early spring, an interval in which the School gladly availed itself of Mr. Bache's instruction in the use of the Plane-table, now recognized as the best topographical instrument.

During the winter, members of the School have, incidentally to receiving instruction, assisted Mr. Bache in making a survey of the Winchester Observatory grounds, in which the elevations and contours are delineated by horizontal planes only three feet apart. Afterward, divided into two sections, the class repeated the survey for practice.

It is much to be regretted that the necessity of Mr. Bache's commencing regular operations in the spring, even earlier than expected, to execute a topographic and hydrographic re-survey of the harbor, dropping temporarily the work north of the city, precludes the possibility of his carrying out the intention of continuing the instruction by some practice in another branch of surveying, such as, last summer, several members of the School had, while serving on his party as hands, for the purpose of acquiring practical knowledge of the Plane-table and extended field-work. During the winter, both the weather and the desirability of having the Winchester Observatory grounds accurately surveyed, led him to determine upon the execution of that work in preference to any other.

By Prof. Pierce's courtesy, Mr. Bache has been enabled to give a reduced projection, on which are plotted the positions of the trigonometrical stations upon which the survey of the New Haven Region depends; also a corresponding list showing their geographical positions; and a list of some of the heights. It will be understood that the trigonometrical stations referred to form but a very small portion of the points actually determined, or to be determined, in the surveys hereabouts. Some are merely the points forming the apexes of the triangles, which, as part of the net work of triangulation of the Coast Survey, enclosing and binding together the whole coast from north to south, happen to fall within the area of the New Haven Region; and others are special determinations with reference to the indefinite multiplication of points less and less remote from each other, to afford a special basis for the topography of the Region.

The day is, we believe, rapidly approaching, when nothing less than a survey of our city, upon the plan which the Coast Survey, at the request of the authorities of Portland, applied to that city, will satisfy the demands of our citizens, who see in our rapid development need of having just such a map as Portland possesses. To this most desirable end the School may congratulate itself on having conduced by taking the first step in demonstrating the utility of carrying out the project, and in being also instrumental in initiating the present surveys, which will naturally lead in the direction indicated.


A. MT. CARM
DICKERMAN
WEST ROCK NORTH
DEAD TREE
HAMDEN CHURCH CUPOLA
RABBIT R
WEST ROCK
EAST ROCK
YALE COLL
LYCEUM
ATHENAEUM
S. W. CUP. ST. PAUL'S
CUP. FOOT WOOSTER
GEOGRAPHICAL POSITIONS
OF THE
COAST SURVEY TRIGONOMETRICAL STATIONS
IN THE
NEW HAVEN REGION
SCALE 1/80000
Harbor
BENHAM'S CHIMNEY
LT. HO.
MILFORD HILL
72° 59' 58' 57' 56' 55' 54' 53' 52'

Contributions to the Study of the New Haven Region.

The work of Mr. Bache furnishes the following important data, which are readily understood by reference to the annexed diagram:

(a.) Geographical positions in the vicinity of New Haven, Conn.

The points indicated upon the annexed diagram have the following positions.

Name of Station.	Latitude,			Longitude.		
	°	′	″	°	′	″
Mount Carmel,	41	25	49.45	72	53	05.34
Dickerman,	41	25	04.59	72	55	22.05
West Rock North,	41	22	56.52	72	57	24.58
Dead Tree,	41	21	11.38	72	58	09.97
West Rock,	41	19	54.03	72	57	21.74
Rabbit Rock,	41	20	29.25	72	50	51.87
Hamden Methodist Cupola,	41	21	09.00	72	55	32.86
East Rock,	41	19	40.05	72	54	06.03
Yale College Lyceum,	41	18	27.74	72	55	24.20
Yale College Athenæum,	41	18	26.20	72	55	25.28
St. Paul's S. W. Spire,	41	18	11.35	72	54	53.59
Manufactory at foot of Wooster st,	41	18	07.09	72	54	18.41
East Haven Spire,	41	16	39.39	72	51	59.40
Benham's Chimney,	41	15	05.46	72	58	34.48
New Haven Light House,	41	14	53.99	72	53	54.84
Milford (hill),	41	13	24.01	73	00	55.27

(b.) Distances between triangulation points within the New Haven Region.

	Meters.
East Rock to West Rock,	4570.9
" " " Mt. Carmel,	11481.9
" " " Hamden Church Cupola,	3406.4
" " " West Rock North,	7617.4
" " " Dead Tree,	6332.1
West Rock to Mt. Carmel,	12477.4
" " " Rabbit Rock,	9128.8
" " " Hamden Church Cupola,	3428.3
" " " Yale Lyceum,	3815.9
" " " S. W. Cupola St. Paul's,	4680.4
" " " Milford Hill,	13016.4
Mt. Carmel to Rabbit Rock,	10352.5
" " " Milford Hill,	25458.5
" " " Dead Tree,	11119.7
New Haven Light to Mt. Carmel,	20251.6
" " " " Milford Hill,	10175.4
Yale Lyceum to Athenæum,	54.3
" " " Rabbit Rock,	7358.2
S. W. Cupola St. Paul's to Rabbit Rock,	7048.6
Rabbit Rock to *West Rock North*,	10194.5

(c.) Heights above mean high-water.*

The heights have been ascertained as follows:

	Ft.
East Rock,	359.496
West Rock,	405.335
Rabbit Rock,	372.571

Starting from top of the granite post on the west side of the north entrance of the Green, ending at summit of Mount Carmel.

	Ft.
Top of granite post,	26.843
Top of first mile-stone from New Haven, on Whitney Avenue,	44.120
Top of second mile-stone on Whitney Avenue,	33.678
East end of overflow Whitneyville Dam,	30.914
West end of the lower step of Whitneyville Church,	65.352
Top of third mile-stone from New Haven, on road to Centreville,	62.533
Top of fourth mile-stone,	73.835
Top of the southernmost of two white posts at top of hill south-east of Augerville Dam,	79.629
Nail in the overflow of Augerville Dam,	40.409
Top of fifth mile-stone,	60.157
Nail at the end of the overflow of the Webbing Co's Dam,	48.814
S. E. corner of lower step of Hamden Church,	77.220
S. E. corner of the lower step of the Centreville House,	71.543
Angle (on top fence) formed by the meeting of the two main roads above Centreville,	102.850
West end of overflow of Beers's Dam,	57.018
The platform scales at Ives's Station,	93.520
S. E. end of a square timber of the overflow of Ives's Dam,	68.900
East end of the overflow of Ives's new Dam,	75.421
The third stone from the south-west end of the overflow of F. Ives's Dam,	90.582
Top of leaning post at corner of Kimberly's store, near Mt. Carmel station,	112.429
Top of large cedar horse-post just beyond corner of road leading back of Mt. Carmel to Wallingford,	111.049
Mt. Carmel (highest point of rock north of bolt-hole under Coast Survey signal,)	736.025

* The difference between mean high-water and mean low-water, as determined by observations during one lunation, is 6.25 ft.

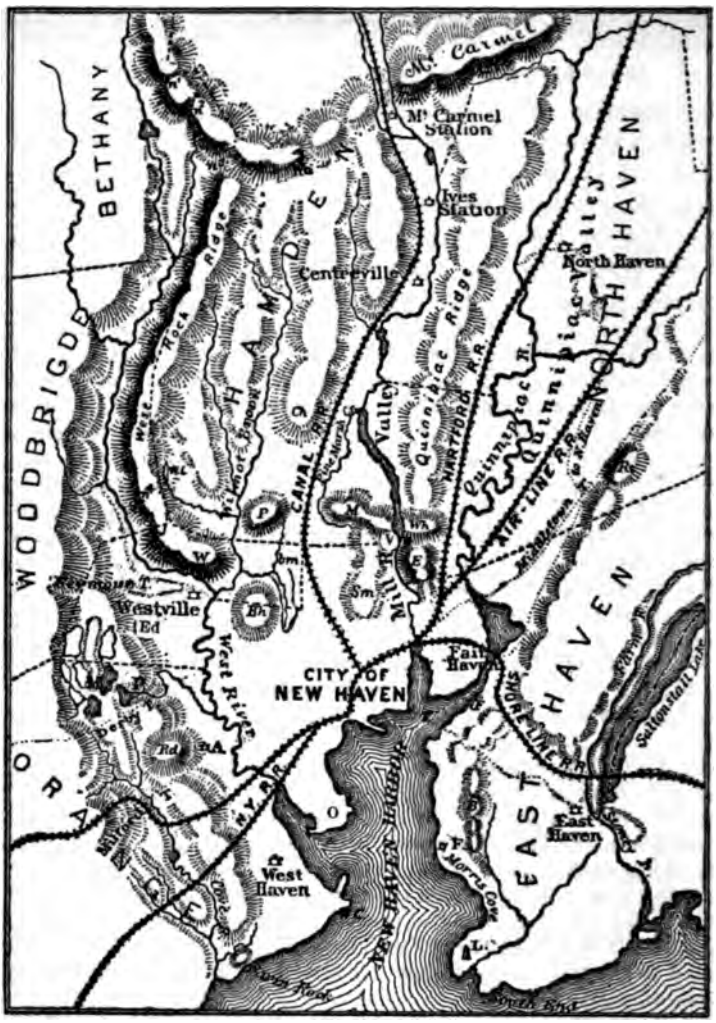
(d.) Physical Features of the New Haven Region.

In connection with this statement of Mr. Bache, the following scription of the principal features of the New Haven region, by of. James D. Dana, will be found interesting. A fuller state- ent of the geological characteristics, by the same authority, will found in the Transactions of the Connecticut Academy, vol. ii. ie map is taken by Prof. Dana's permission from that volume.

"Either side of New Haven bay,—an indentation of the coast out four miles in depth,—there is a north-and-south range of lls, the trap and sandstone ridges of East Haven and North ven on the east, and the eastern portion of the Woodbridge ateau on the west; and these make the eastern and western undaries of the New Haven region. Their height, which is eatest to the North, probably nowhere exceeds 600 feet. The dth of the region varies from about four miles on the south to ven on the north, and the whole length from the sound to Mt. rmel—its true northern topographical limit—is twelve miles. The northern half of the region is divided longitudinally by two es of ridges: (1) the long West Rock trap ridge near the western le, four hundred feet and upward in height; and (2) nearly dway in the area east of West Rock, the short isolated East ock (E) range of trap and sandstone, and the continuation of is range northward to Mt. Carmel in the low Quinnipiac sand- one ridge which divides the waters of Mill River and the Quin- piac.

The New Haven region hence consists in its northern half of ree subordinate north-and-south regions; (1) a narrow valley est of West Rock, drained by West River; (2) a broad ntral plain (the Hamden plain), continuous with the New Haven ain rising into hills to the northward, and drained along the st side by Mill River; and (3) a wide eastern portion occupied the river-course and the extensive meadow lands of the Quin- piac, in other words, the wide valley of the Quinnipiac. South East Rock, the central New Haven plain blends with that of e Quinnipiac.

The West Rock ridge to the north throws off a branch on e east which curves around to Mt. Carmel and forms the rthern boundary of the central of the three subordinate gions. This central region is partly subdivided across, on a rving line between West and East Rocks, by two short trap lges; Pine Rock (P), a third of a mile from West Rock, and Mill ock (M,) which adjoins East Rock; the width of the interval be- een the two is nearly a mile. Mill River passes through a deep t in the Mill Rock ridge, at the village of Whitneyville."



Explanation of the map.—A, Allingtown village. B, Beacon Hill. Bh, Beaver hills. Ch, Cherry Hill. E, East Rock range, consisting of East Rock proper to the northwest, Indian Head, and then Snake Rock. Ed, Edgewood, the estate of Donald G. Mitchell, Esq. F, Fort Hale. *F*, Ferry Point, or Red Rock, on the Quinnipiac. J, Judges' Cave, on the West Rock ridge. L, Light House. M, Mill Rock. M P, Maltby Park, only three of the proposed lakes of which are constructed. O, Oyster Point. P, Pine Rock. Rd, Round Hill. Rt, Rabbit or Peter's Rock. Sm, Sachem's ridge. T, Turnpike; also Tomlinson's bridge, across the head of New Haven bay. V. Whitneyville. W, West Rock, the south end of West Rock ridge. W C, West Cape, or West Haven Point. Wh, Whitney Peak. W L, Wintergreen Lake, just north of Wintergreen Falls. Wn, Warner's Rock. *bm*, Beaver Pond Meadows; *m*, Mineral Spring, southeast of North Haven; *n1*, *n2*, *n3*, *n4*, different notches in the West Rock ridge; *n1*, *n2*, the upper and lower Bethany *Notches; n3*, the Hamden Notch; *n4*. Wintergreen Notch.

Scale 4-10ths of an inch to the mile.

(e.) Botanical Characteristics.

Professor Eaton has furnished the following hints in respect to botanizing near New Haven:

In place of the usual "Catalogue of plants collected in the vicinity of ———," it seems better to indicate a few of the neighboring spots most interesting to botanists. Conspicuous among these is Mount Carmel, to which the botanical students make an annual excursion. The collector of plants should visit it in May, and go up the western gorge from the south, finding on the way *Dentaria laciniata*, *Mitella diphylla*, *Trillium erectum* and *T. cernuum*, *Arabis lævigata*, *Clematis verticillaris*, *Sambucus pubens*, *Betula lutea*, *Viola pubescens*, *Asarum Canadense*, *Sanguinaria Canadensis*, and many of the commoner species. The leaves of the broad-leaved onion, *Allium tricoccum*, are also very common in this gorge. Ascending the peak to the east of the gorge, there is discovered a pond or swamp almost on the very top, where in August the rather uncommon fern, *Woodwardia Virginica* may be had in abundance. From this point the best route is N.E. to Payne's Hole, a deep ravine immediately south of the Coast Survey signal. Along the route one may find *Cypripedium acaule* and C. *parviflorum*, *Viola blanda*, and *Staphylea trifolia*, and near the little stream in Payne's Hole are *Claytonia Virginica*, *Caulophyllum thalictroides*, *Actæa alba* and *A. rubra*, and *Habenaria viridis*, var. *bracteata*. One may now descend either by following the stream down the north slope, or by taking a path which will, after many windings, come down a gorge on the south side, about a mile from the western end of the range.

In the ravine of Roaring brook, in Cheshire, are found many of the plants of Mount Carmel, and in addition some interesting ferns and mosses. *Aspidium Goldieanum* and the walking-leaf (*Camptosorus rhizophyllus*) are there, besides many which occur in most damp, shady ravines.

The extensive range of woods, hills, swamps and streamlets, which lies between Maltby Park and the road leading N.W. from Westville, is at all times of the year rich in rare plants. *Geum rivale*, *Saxifraga Pennsylvanica*, three white violets, *Dentaria diphylla*, *Cardamine rhomboidea*, and *Rubus triflorus*, occur along the rivulet which flows across the Woodbridge road, and further toward the middle of the wilderness there is always good collecting. Several *Orchidaceæ* are found only here, as *Aplectrum hyemale* and *Habenaria Hookeri*, while two or three Cypripedia

Pogonia verticillata, *Habenaria tridentata*, and the two species of *Liparis* are all to be found by patient search. Several rare ferns occur on the serpentine rocks of Maltby Park, and near them is abundance of the fringed gentian, (*G. crinita*).

Mosses and hepatic mosses are abundant in this whole tract: one excursion in December afforded thirty of the former, all in fruit, and a dozen of the latter, among them the rare and most beautiful *Trichocolea tomentella*.

The Beaver meadows, though much injured for botany by cultivation and filling up, still afford *Sarracenia purpurea*, *Potentilla palustris*, *Rhexia Virginia*, *Pogonia ophioglossoides*, *Calopogon pulchellus*, *Cassandra calyculata*, *Lemna trisulca*, and rarely *Brasenia peltata*, while *Calla palustris* and the beautiful *Arethesa bulbosa* have disappeared.

The ravine below Wintergreen falls is our only station for *Viola rotundifolia*, which comes in April, with scanty trailing arbutus, and here are also several rare mosses, among the rest the rarest *Buxbaumia aphylla*.

The meadows between Tomlinson's bridge and Fort Hale contain the yellow fringed orchis (*H. ciliaris*), and *Parnassia Caroliniana;* and the salt marshes so abundant about New Haven afford a great number of characteristic species. A little salt marsh which separates South End from the main land is the only station known near New Haven for a shrubby dicœcious composite, *Baccharis halimifolia*, blossoming late in the autumn, and the slopes of the cliff beyond Fort Hale give us *Solidago rigida*, which with *Liatris scariosa* occurs also on the West Haven shores. For *sea-mosses* the richest stations are the shores of the Thimble Islands, where, in the tide pools, may be had *Corallina officinalis*, *Callithamnion Baileyi*, several *Ceramia* and *Polysiphoniæ*, *Laminaria saccharina*, *Chorda lomentaria*, *Punctaria latifolia*, *Cladophora glaucescens*, and others more common, while the rocks just below low water mark yield *Phyllophora membranifolia* and other forms. The two most beautiful of all our sea-mosses, *Grinnellia Americana* and *Dasya elegans*, are occasionally thrown upon the shores near New Haven, but their places of growth are not yet ascertained.

The banks of the Housatonic, and its valley, contain many plants characteristic of alluvial soil, and the shores and bottom of Lake Saltonstall richly repay a careful search. At the northern end of the lake, on the small patch of alluvion, is the sweet-scented

Cyperus inflexus, under the water are *Schollera graminea*, and several species of *Potamogeton*, while on the high ridge west of the lake is a station for *Linnæa borealis*.

There is not a hill or meadow, swamp or hedge-row near New Haven, where some interesting plants may not be found at one season or another; but the places above referred to are among the richest places for a botanist to visit.

Additions to the Zoological Collections.

A. E. VERRILL, CURATOR; S. I. SMITH, ASSISTANT.

The most important feature of the special zoölogical work during the year has been the coöperation of the curator and Mr. S. I. Smith in the researches of the U. S. Fish Commissioner, Prof. S. F. Baird, of the Smithsonian Institution, in reference to the fishes of the coast and inland waters, their food, modes of reproduction, rate of growth, migrations, and habits generally, as well as upon the character of the fisheries and their effects upon the fishes. Hitherto, very little positive and reliable information in regard to the habits and food even of our common marketable fishes has been published, and most of the statements upon which the legislation in regard to the fisheries has been based are but crude "guesses" of fishermen, who, at best, have made only local and imperfect observations, and cannot draw reliable inferences.

In order to obtain any solid basis of facts upon which alone general and even local legislation can be safely based, it was necessary to undertake new and very extended investigations in the most systematic and scientific manner, for every kind of information desired. Arrangements were accordingly made with Prof. Baird for the fullest coöperation in these researches. The part of the work specially in charge of the curator and Mr. Smith has been the investigation of the *food* of the fishes, and the sources from whence it is derived, together with the character of the bottoms, temperature of the waters, etc. It was soon found that to obtain such information would involve a systematic zoölogical survey, as complete as possible, in each region investigated. In the spring vacation, the curator, with Mr. S. I. Smith and Prof. J. E. Todd (then a student in the zoölogical department), visited Great Egg Harbor, N. J., and made many useful observations upon the food of the fishes of that region, and secured a valuable collection both of the fishes and the invertebrata. During the summer vacation, in coöperation with Professor Baird and his

party, a thorough zoölogical survey of Vineyard Sound and the adjacent waters was undertaken by the curator and Mr. S. I. Smith, aided by Prof. J. E. Todd, Prof. A. Hyatt, Dr. A. S. Packard, and others.

The collections made during these explorations are by far the largest and most complete ever made upon any portion of our coast, both for the fishes and the invertebrata. All of the latter have been sent here for identification and description; after this shall have been done, the Yale museum will receive a complete series, and the duplicates will be sent to other institutions. A large portion of this work of identification has been already completed and the curator has in preparation a lengthy report upon the invertebrate faunæ and physical features of the regions explored, which will be illustrated by charts showing the localities of the dredgings, character of the bottom, depth of water, temperature, etc, and by about three hundred figures of the animals obtained. Prof. Baird has also given a series of the fishes, including several that are entirely new to our coasts, obtained at the same time by his party. Among the fishes are a considerable number of skins of sharks, rays, and other large species.

Preparations have been made and apparatus constructed to carry on, during the next vacation, still more extensive explorations of the same kind, in the Bay of Fundy and on St. George's Bank. All the naturalists engaged in these explorations have cheerfully given their time and labor without any pecuniary compensation.

Mr. S. I. Smith, during a part of the summer, was also engaged in dredging in the deeper parts of Lake Superior, in connection with the U. S. Lake Survey. From this source a very interesting collection was received.

During the past year numerous other important additions have been made to the zoölogical collections, and a large amount of time has been devoted to their scientific arrangement and description.

Prof. O. C. Marsh and party contributed many valuable skeletons and skulls and other specimens from the Rocky Mountains and California. Prof. Marsh has also presented a fine collection of the birds and mammals of California, including about 350 specimens collected by Mr. A. Provo Kluit. He has also given skins and skeletons of two species of Apteryx from New Zealand and a large number of valuable skeletons from various sources. Mr. G. *B. Grinnell* (Yale, 1870), has forwarded numerous bodies and bones

of animals, from which excellent skeletons have been made. Among them were two ostriches, an elephant, etc. An interesting collection of insects, reptiles, and other things from South Africa has been received from Mrs. Sarah Abraham. Dr. H. C. Yarrow, U. S. A., has sent a very valuable collection of marine invertebrata from Fort Macon, N. C. Mr. J. F. Whiteaves, of Montreal, has given a small but important collection from his dredgings in the Gulf of St. Lawrence; some of these are from the greatest depths that have yet been reached in dredging on the northern coasts of America. In addition to these we have received gifts of value from many other friends of the College, which will be noticed elsewhere.

Additions to the Geological Collections.

O. C. MARSH, CURATOR.

The present year has been an important one for this Department, as the Museum has received the largest accessions ever made in a single season. The new material is, moreover, especially valuable, as it contains a very large number of fossil vertebrates new to science. A number of these, including some of great interest, have already been described by the curator in the *American Journal of Science*. In arranging and examining these and other additions to the Museum, important aid has been given by Mr. Harger, Assistant in Paelontology. Most of the recent acquisitions cannot, unfortunately, be now exhibited for want of room, or even examined and catalogued for want of needed assistance in the working force of the Museum.

Continued efforts have of late been made by this department to increase the collection in Osteology, more especially as an aid to the investigations of extinct vertebrate remains. More than two hundred skeletons of recent animals, most of them typical specimens, have been secured during the last year, so that ample facilities for the study of Comparative Osteology are now afforded.

The most important gifts received during the past year are the various collections made by the Yale Expedition in charge of Professor Marsh, which spent the summer and autumn of 1871 in geological explorations in the Rocky Mountain region and on the Pacific Coast. This party, like that of the previous year, was essentially a private one, consisting of Professor Marsh and ten

recent graduates of the College. The special object of the Expedition was to study the extinct vertebrate animals of the far West, and the first investigations were made in July and August in the Cretaceous deposits of Southwestern Kansas, where numerous new species of birds, reptiles, and fishes were discovered. During September and October the Tertiary beds of Wyoming and Idaho were examined, and a large number of new fossil mammals, birds, reptiles and fishes, were collected. The remainder of the autumn was spent in Eastern Oregon, where many new and interesting Tertiary animals were found. After a short visit to California the party returned East, some by land, and others, with Professor Marsh, via Panama.

The expedition, although attended with much hardship, difficulty and danger, was in all respects successful, and resulted in placing in the Yale Museum not less than 15,000 specimens of fossil vertebrate remains, including probably seventy-five undescribed species, some of them of great interest. Large collections of recent animals, and many valuable ethnological specimens were also secured. Measured by the expenditure of the party, and the important assistance received from the Government and other sources, the results of the expedition may fairly be regarded as representing a gift to the Museum of not less than $40,000, and the expedition of the previous year an equal amount. The combined collections of extinct vertebrates made by the two expeditions place the Yale Museum in this respect far in advance of any in this country.

Among the other noteworthy additions to the Museum during the past year may be mentioned an interesting collection of fossil animals from the Tertiary of Greece, received in exchange from the University of Athens, through the Hon. Robert P. Keep, of the Class of 1865, late U. S. Consul at Piraeus, Greece. A valuable series of vertebrate fossils from the Tertiary of Oregon has been presented by Rev. Thomas Condon, of Dalles City, Oregon, who likewise rendered important aid to the Yale party, last autumn, during their explorations in that region. A large collection of the remains of *Dinornis* and other extinct birds of New Zealand, and a fine specimen of *Ichthyosaurus intermedius*, from England, have been given by Professor Marsh. A gift of one hundred and fifty dollars was received from Professor J. D. Dana to aid the explorations of the Western Expedition, and other important contributions have been made to the Museum which will be fully acknowledged elsewhere.

Archæology and Ethnology.

The collections in this department have been materially increased during the past year, mainly through a few large gifts; but comparatively little can be done until an endowment is secured, which will provide for the systematic care and increase of specimens already obtained, and a suitable place for their preservation.

The most important acquisitions since the last Report have been a large collection of very perfect stone implements of pre-historic age from Scandinavia; two collections of archælogical specimens from California, including some supposed to be of great antiquity; an ancient statue, several gold images, with various specimens of pottery and stone from Central America; and a long series of Indian Stone implements from Ohio, together about 1200 specimens, which were presented by Professor Marsh. Among the other noteworthy additions may be mentioned a series of twelve fine antique vases and several other antiquities from Chiriqui, Central America, presented by Samuel Hubbard, Esq., of San Francisco; some rare specimens of ancient pottery from Peru, the gift of Wm. Nelson, Esq., of Panama; a suite of interesting Indian implements from the Columbia River, given by Rev. Thomas Condon, of Dallas City, Oregon, and a number of weapons and other specimens from Alaska, presented by Gen. John E. Miller, of San Francisco. The remaining gifts will be acknowledged in the regular list of donations.

Lectures to Mechanics.

The seventh course of lectures was given as follows:

I.	Mon.,	Feb. 5.	Introductory Lecture:—Relations of Mind and Matter.	President Porter.
II.	Thurs.,	" 8.	Principles of Elocution,	Mark Bailey.
III.	Mon.,	" 12.	Recent Contributions to American Geography,	D. C. Gilman.
IV.	Thurs.,	" 15.	Experiments on Sound, illustrating the method of determining the motions of the heavenly bodies by the Spectroscope,	Alfred M. Mayer.
V.	Mon.,	" 19.	Our Common Weeds,	D. C. Eaton.
VI.	Thurs.,	" 22.	The U. S. Weather Signal Service,	W. H. Brewer.
VII.	Mon.,	" 26.	Phosphorus,	S. W. Johnson.
VIII.	Thurs.,	" 29.	The Mechanics of Europe,	B. G. Northrop.
IX.	Mon.,	Mar. 4.	Tilghman's Sand-Blast Engraving Process,	G. F. Barker.
X.	Thurs.,	" 7.	Steam-Engine Indicator,	C. B. Richards.
XI.	Mon.,	" 11.	*Forces of Inanimate* Nature,	W. A. Norton.

XII.	Thur., Mar. 14.	The Prismatic Spectrum,	C. S. Hastings.
XIII.	Mon., " 18.	The Telescope,	C. S. Lyman.
XIV.	Thurs., " 21.	Color,	J. H. Niemeyer.
XV.	Mon., " 25.	Steam-Boilers,	W. P. Trowbridge.
XIV.	Thurs., " 28.	The Darwinian Hypothesis applied to the Human Race,	A. E. Verrill.

Anniversary.

The anniversary exercises were held in Sheffield Hall, on Monday, July 10, 1871; a portion of the Theses being publicly read at 9 o'clock in the morning, and the remainder at 8 o'clock in the evening, in the presence of the State Board of Visitors, the Corporation of the College, the Instructors, and other friends of the school.

The candidates for degrees, with the subjects of their theses, are given in the following schedule. The degrees were conferred on these candidates by President Woolsey on Commencement day, July 13. Theses marked with a star were read in the evening.

CANDIDATES FOR DEGREES.

WITH THE SUBJECTS OF THEIR GRADUATION THESES.

DOCTORS OF PHILOSOPHY. (2)

BERNARD JAMES HARRINGTON, B.A. (McGill Univ.), *Montreal, Canada.* On the Siemens-Martin Steel Process.

This thesis occupies about sixty manuscript pages, with working drawings of furnaces, and a detailed account of the process, from a study of its practice at Trenton, N. J. It also contains a chemical investigation of the materials used, and the changes which take place in their conversion to steel, with quantitative analysis of different grades of Martin steel.

*HENRY SHALER WILLIAMS, Ph.B., *New Haven.* On the Muscular System of Turtles.

This thesis contains ninety-five manuscript pages with numerous drawings. The greater part of it is devoted to a careful and original description of a fresh-water Turtle (*Trionyx*), of which the anatomy has not been previously described.

CIVIL ENGINEER. (1)

WILLIAM DENNIS MARKS, Ph.B., *St. Louis, Mo.* Design of a Bowstring Girder Bridge.

BACHELORS OF PHILOSOPHY. (28)

*HORACE ANDREWS (Engineering), *Tarrytown, N. Y.* On the most Advantageous Employment of Wind as a Motive Power.

EDWIN FAXON BACON (Select), *Norwalk.* On the Rise of the Mark Brandenburg.

LUTHER WHITE BURT (Engineering), *Hartford.* On the Hartford Double Tunnel.

*GEORGE BENJAMIN CHITTENDEN (Engineering), *East River.* On Safety Railway Brakes.

*RUSSELL WHEELER DAVENPORT (Chemistry), *New York City.* On the Hot Blast Applied to Iron in Smelting.

WILLIAM CECIL DURAND (Select), *Milford.* On the Historical Changes of Alsace and Lorraine.

CHARLES HASCALL DWINELLE (Agriculture), *Oakland, Cal.* On Forage Crops for Dry Climates.

CHARLES ADDISON FERRY (Engineering), *New Haven.* On the Comparative Value of Iron and Steel for Bridges.

CHARLES HENRY GREEN (Engineering), *Cincinnati, O.* On the Generation and Utilization of Steam.

WOODFORD GRISWOLD (Engineering), *New Britain.* On the Modern
s of Laying Foundations in Water.

ICCULLOCH KEASBEY (Select), *Newark, N. J.* On the Fire Clay Deposit
Jersey.

EDERICK KLEIN (Engineering), *New Haven.* On Turbine Water Wheels.

RANVILLE LOBDELL (Chemistry), *Wilmington, Del.* On the Siemens-
Steel Process.

ILLIAM MATHER (Engineering), *New Haven.* On the Teeth of Wheels.

D MERRIMAN (Engineering), *Plantsville.* Preliminary Design of a
ing Wrought Iron Roof.

UIS MOORE (Engineering), *Fond du Lac, Wis.* On an Iron Pier of the
n Viaduct.

OBART PIERPONT (Engineering), *North Haven.* On a newly invented
for Raising Water from Deep Mines.

EUGENE POWELL (Engineering), *North Haven.* On Centrifugal Pumps.

NKLIN QUIGLEY (Engineering), *Wilmington, Del.* On the Potomac
ict.

LOCKWOOD SANFORD (Engineering), *New Haven.* On the Bucket
as a Hydraulic Motor.

ADFORD SARGENT (Chemistry), *New Haven.* On the Working of Zinc
Bethlehem, Penn.

LINTON TERRY (Engineering), *Terryville.* Some Calculations for a
ht Iron Crane.

EN ZIEGLER (Chemistry), *Philadelphia, Pa.* Examination of a Copper
om Jones' Mine, Berks Co., Penn.

Prizes.

llowing prizes were announced at the anniversary.

CLASS OF 1871.

ce in French, a prize of $10 awarded to CHARLES H. DWINELLE, *Oak-
al.*

ce in Botany, a prize of $15 awarded to MANSFIELD MERRIMAN, *Plants-
ith honorable mention of C. H. DWINELLE, second in rank.

ce in Zoology, a prize of $15 awarded to GEORGE G. LOBDELL, *Wilming-
l.*

ce in Chemistry, a prize of $15 awarded to GEORGE G. LOBDELL, *Wilming-
l.*

nce in Civil Engineering, a prize of $15 awarded to D. H. PIERPONT, *
Haven.*

nce in Mineralogy, a prize of $15 divided between R. W. DAVENPORT, *
ork City*, Class of 1871, and T. M. PRUDDEN, *New Haven*, Class of 1872,
n rank.

CLASS OF 1872.

ce in Mathematics, a prize of $15 awarded to DANIEL W. HERING, *Johns-
ld.*, with honorable mention of FRANK O. MAXSON, *Norwich*, second in

ce in English, a prize of $15 awarded to GEORGE N. MILLER, *Wallingford.*

CLASS OF 1873.

ce in the studies of Freshman Year, a prize of $15 awarded to WILLIAM
AIFE, *Pittsburg, Pa.*, with honorable mention of WILLIAM H. JENKS,
ille, Pa., second in rank.

ERRATUM.

Page 11, for "early in 1872," read "December 13, 1871."

APPENDIX.

1. LIST OF BENEFACTORS.
2. CATALOGUE AND PROGRAMME.

APPENDIX.

Contributions to the Sheffield Scientific School.

The following list includes the names of those persons who have contributed at any time the sum of one hundred dollars or more for the endowment and maintenance of the Sheffield Scientific School. The principal gifts of specimens, models, etc., have been acknowledged in the successive annual reports.

I.

Mr. Sheffield's Donations.

The gifts of Mr. Joseph E. Sheffield, of New Haven, to this department of Yale College began in 1856, and have been renewed at frequent intervals from that time to the present.

The principal donations may be thus grouped:

1. The building in Grove street, known as Sheffield Hall, twice enlarged and refitted, including the observatory towers, an equatorial telescope, a meridian circle, a collection of models in engineering and architecture, furniture, cases, etc.
2. The new building in Prospect street, now in process of construction, north of Sheffield Hall.
3. A fund of $130,000 for the professorships.
4. A library fund of $10,000, increased to $12,000, and the Hillhouse Mathematical library, purchased at a cost of $4,000.
5. A gift to the Collier Cabinet of $2,700.
6. Frequent contributions to the current expenses.

These gifts amount to at least $250,000,—not including the building which is now in process of construction.

II.

The Congressional Fund.

The Congress of the United States by an Act dated July 2, 1862, known as the Morrill Bill, gave to the State of Connecticut a portion of Land Scrip, which was given by the Legislature of 1863 to the Sheffield Scientific School. This scrip yielded the sum

of $135,000, which is devoted by the law of Congress to the maintenance of a college in which the modern scientific studies are to predominate.

III.

The Higgin Professorship of Dynamic Engineering.

This professorship was endowed in 1871 by Mrs. Robert Higgin, of Liverpool, Eng., by a gift of £5,000, which yielded the capital of $28,000. The professorship was designated in memory of her deceased husband, who led a long and honorable mercantile career, distinguished by many generous contributions to the educational and charitable foundations of the place of his residence.

IV.

The Norton Professorship of Agriculture.

This professorship is regarded as endowed by the national land grant already referred to. Its designation commemorates the liberal purposes of John T. Norton, Esq., a skillful agriculturist of Farmington, Conn., one of the earliest friends of this department of Yale College, and his son, Professor John P. Norton, who died in 1852, after having served the college and the interests of agriculture in the State with rare ability. The father gave $300, annually for five years, for the support of the Analytical Laboratory, and the son bequeathed to the Scientific School his books and apparatus, valued at $2,500.

V.

The Collier Cabinet of Mechanics.

The Collier Cabinet of Mechanics and Physics was instituted in 1869, in memory of a former student of Mechanical Engineering, Mr. Thomas Fassitt Collier of St. Louis, who died in Salt Lake City. His brother, Mr. M. Dwight Collier, gave the sum of $6,000 for the purchase of apparatus and models, and other gentlemen contributed additional amounts as follows:

Maurice D. Collier, in memory of the late Thomas Fassitt Collier,	$6,000
Joseph E. Sheffield, 10,000 francs (in gold), equivalent to	2,700
Henry Farnam,	1,000
Edward E. Salisbury,	200
John A. Blake,	100
Eli W. Blake,	50
Alfred Walker & Co.,	25

The Novelty Iron Works of the City of New York, through Howard Potter, Esq., in 1870, gave the valuable collection of Drawings and Working Plans, many thousand in number, which

had been accumulated in the business of that establishment. A catalogue of the Drawings was published in the Report of the School for 1871.

VI.

The General Instruction Fund.

The General Instruction Fund, applicable to any of the current expenses of the School, is made up of the contributions of the following persons, which are permanently invested, and yield an annual income:

William Walter Phelps, New York,	$10,000
Joseph Sampson, New York,	6,000
William W. Boardman, New Haven,	5,000
Richard S. Fellowes, New Haven,	5,000
Oliver F. Winchester, New Haven,	5,000
William E. Dodge, New York,	3,000
James E. English, New Haven,	2,000*
Joseph Battell, New York,	1,000
Jeremiah Day, New Haven,	1,000
William Howe Downes, Birmingham, Conn.,	1,000
Henry Hotchkiss, New Haven,	1,000
Tredwell Ketcham, New Haven,	1,000
William B. Ogden (land), New York,	1,000
Pelatiah Perit, New York	1,000
Samuel Russell, Middletown, Conn.,	1,000
Wells Southworth, New Haven,	1,000
Augustus R. Street, New Haven,	1,000
James M. Townsend, New Haven,	1,000
Ezekiel H. Trowbridge, New Haven,	1,000
Henry Trowbridge, New Haven,	1,000
Thomas R. Trowbridge, New Haven,	1,000
Eli Whitney, New Haven,	1,000
Robert Benner, Astoria, L. I.,	500
Eli W. Blake, New Haven,	500
William Bostwick, New Haven,	500
Jarvis Brush, New Haven,	500
Joshua Coit, New Haven,	500
Henry A. Du Bois, New Haven,	500
William & E. T. Fitch, New Haven,	500
Marshall Jewell, Hartford,	500
Harmanus M. Welch, New Haven,	500
John J. Skinner, Oneida, N. Y.,	375
William G. Abbot, Norwich,	300
Timothy Dwight (Yale College),	300
William H. Elliot, New Haven,	300
Morris Tyler, New Haven,	300
Frederick J. Leavens, Norwich,	100

* In addition to $3,000 given for income.

VII.

The Holmes Scholarship.

The Holmes Scholarship was founded by Samuel Holmes, Esq., of New York City, by a gift of $1,000, the income of which is to be annually paid to a meritorious scholar, designated by the Trustees of the Bronson Library in Waterbury, Conn., or in case of their failure to appoint, by the Professors of the Scientific School.

VIII.

The Bronson Fund for Comparative Anatomy.

Dr. Henry Bronson, of New Haven, for many years a professor in the Medical Institution of Yale College, has given the sum of $1,000 to promote the study of Comparative Anatomy and Zoölogy.

IX.

The Library.

The Library of the Scientific School consists of the Hillhouse Mathematical Library, purchased from Dr. William Hillhouse, in 1870, by Mr. Sheffield for the sum of $4,000; and of a collection of books bought by the subscriptions of the following gentlemen as

GIFTS FOR THE COMMENCEMENT OF A LIBRARY.

William W. Boardman,	$250
Jarvis Brush,	100
Tredwell Ketcham,	500
Perkins & Chatfield,	200
Joseph Sampson,	500
Henry Trowbridge,	100
Harmanus M. Welch,	100
John D. Wheeler,	250
	$2,000

Its current expenses and accessions are paid for by the income of a special Library Fund of $12,000, given by Mr. Sheffield. Many valuable gifts of books, magazines, and prints have been received from other individuals. Dr. William Hillhouse has given the sum of $500, for the binding of books.

X.

Subscriptions for Current Expenses.

The School has recently received the following subscriptions toward *the defrayal of current* expenses.

Subscriptions to Income.

James E. English, New Haven, $1,000 annually for 3 years,	$3,000.00
Edward A. Mitchell, New Haven, $250 annually for 10 years,	2,500.00
A friend,	2,000.00
John D. Wheeler, New Haven, $300 annually for 5 years,	1,500.00
Frederick H. North, New Britain, $300 annually for 5 years,	1,500.00
Colin M. Ingersoll, New Haven, $60 for 5 years,	300.00
Jeremiah A. Bishop, New Haven, $60 for 5 years,	300.00
Matthew G. Elliot, New Haven, $50 for 5 years,	250.00
Edward S. Scranton, New Haven,	250.00
Benjamin Douglas, Middletown,	100.00
Henry Stanley, New Britain,	100.00
Isaac Thomson, New Haven, $50 for 2 years,	100.00
James D. Dana, New Haven (Yale College),	80.00
William Gamble, New Haven,	50.00
Perkins & Chatfield, New Haven, amount of bill,	83.82

XI.

Other Gifts for Special Purposes.

1. For the Agricultural Museum—
   Robert Benner, Astoria, N. Y., $300.00
2. For the Mining and Metallurgical Museum—
   James D. Dana, Yale College, 500.00
3. For the Binding of Books—
   William Hillhouse, New Haven, 500.00
4. For the purchase of a Chronometer—
   Ezra C. Read, New Haven, 150.00
5. For the purchase of Maps and Geographical Models—
   Wm. Johnson, New Haven, 500.00
6. For purposes not yet designated—
   The Class of 1869 (S. S. S.) 210.00
   The Class of 1870 (S. S. S.) 140.00
7. For Prizes:—

The Berzelius Trust Association (in gold),	$170
Jarvis Brush,	50
Benjamin Silliman (in gold),	50
The Sigma Delta Chi Society,	50
A friend,	400
Other friends,	125
Charles Z. Brown,	25

8. For assistance of a needy scholar—
   Rev. Leonard W. Bacon, 100

XII.

Proposed Professors' Fund.

A friend of the School has offered $10,000, on condition that $50,000 is raised before Commencement in 1873, as a Professor's Fund. A second subscription of like amount, accompanied by a *check* for one-half the sum, has likewise been received. This *leaves* the amount of $30,000 as yet unprovided for.

PROGRAMME OF STUDIES,

AND

CATALOGUE,

For the College Year 1871–1872.

Corporation of Yale College.

The Governor, Lieutenant Governor, and six senior Senators of the State of Connecticut are *ex officio* members of the Corporation.

PRESIDENT.

REV. NOAH PORTER, D.D., LL.D.

FELLOWS.

HIS EXCELLENCY MARSHALL JEWELL, HARTFORD.

HIS HONOR MORRIS TYLER, NEW HAVEN.

REV. JOSEPH ELDRIDGE, D.D., NORFOLK.

REV. GEORGE J. TILLOTSON, M.A., PLAINFIELD.

REV. EDWIN R. GILBERT, M.A., WALLINGFORD.

REV. DAVIS S. BRAINERD, M.A., LYME.

REV. ELISHA C. JONES, M.A., SOUTHINGTON.

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HON. ELISHA JOHNSON, HARTFORD.

HON. EZRA HALL, MARLBOROUGH.

HON. CHARLES L. GRISWOLD, CHESTER.

HON. HENRY TUTTLE, HAMDEN.

HON. ELI CURTISS, WATERTOWN.

HON. FREDERICK P. BISSELL, WATERTOWN.

TREASURER,

HENRY C. KINGSLEY, M.A.

LIBRARIAN,

ADDISON VAN NAME, M.A.

SECRETARY,

FRANKLIN B. DEXTER, M.A.

GOVERNING BOARD,

APPOINTED BY THE CORPORATION OF YALE COLLEGE.

President.

REV. NOAH PORTER, D.D., LL.D. — 31 Hillhouse av.

Professors.

ARRANGED IN THE ORDER OF THEIR GRADUATION.

WILLIAM A. NORTON,
Civil Engineering and Mathematics. — 72 Prospect st.

CHESTER S. LYMAN,
Physics and Astronomy, Theoretical and Practical. — 161 Temple st.

WILLIAM D. WHITNEY,
Linguistics and German. — 246 Church st.

WILLIAM P. TROWBRIDGE,
Dynamic Engineering (HIGGIN *Professor*). — 38 Elm st.

GEORGE J. BRUSH,
Mineralogy. — 14 Trumbull st

DANIEL C. GILMAN,
Physical, Historical, and Political Geography. — 37 Hillhouse av.

SAMUEL W. JOHNSON,
Agricultural and Analytical Chemistry. — 54 Trumbull st.

WILLIAM H. BREWER,
Agriculture (NORTON *Professor*). — 131 Temple st.

DANIEL C. EATON,
Botany. — Sachem st., c. Prospect.

THOMAS R. LOUNSBURY,
Anglo Saxon and Early and Modern English. — 187 Temple st.

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OSCAR D. ALLEN,
Metallurgy and Assaying. — 28 Clark st.

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LECTURERS, INSTRUCTORS AND ASSISTANTS,*

ADDITIONAL TO THE GOVERNING BOARD.

BY AUTHORITY OF THE SUPERINTENDENT OF THE SURVEY.

RICHARD M. BACHE, of the U. S. Coast Survey,
The Use of the Plane Table. — Chapel st.

———— ————*

FRANCIS BACON, M.D., Professor in the Yale Medical School,
The Laws of Health. — 32 High st.

MARK BAILEY, of the Academical Department,
Elocution. — Temple st.

JOHN H. NIEMEYER, Professor in the Yale School of the Fine Arts,
Free Hand Drawing. — 93 Olive st.

LOUIS BAIL,
Mechanical and Topographical Drawing. — 43 Park place.

F. R. HONEY,
Orthographic Projection. — Church st.

EUGENE C. DELFOSSE,
French. — 108 York st.

WILLIAM G. MIXTER,
Elementary and Analytical Chemistry. — 14 S. H.

SIDNEY I. SMITH,
Zoölogy. — 148 College st.

DANIEL H. WELLS,
Analytical and Descriptive Geometry. — 99 Bradley st.

CHARLES S. HASTINGS,
Physics. — 90 Grove st.

RUSSELL W. DAVENPORT,
Chemistry. — S. H.

MANSFIELD MERRIMAN,
Mathematics. — 209 Elm st.

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* The Professorship of Military Science is temporarily vacant.

SHEFFIELD SCIENTIFIC SCHOOL.

GRADUATE STUDENTS.

Horace Andrews, PH.B.	*Tarrytown, N. Y.*	8 York sq.
Edward Swoyer Breidenbaugh, M.A. Pennsylvania College,	*Gettysburg, Pa.*	22 York sq.
Charles Augustus Brinley, PH.B.	*Hartford,*	42 Prospect st.
George Benjamin Chittenden, PH.B.	*East River,*	187 Temple st.
Neville B. Craig, B.A.	*Pittsburgh, Pa.*	33 Prospect st.
Edward Salisbury Dana, B.A.	*New Haven,*	24 Hillhouse av.
Russell Wheeler Davenport, PH.B.	*New York City,*	S. H.
Augustus Jay DuBois, C.E.	*New Haven,*	41 Howard av.
Wheeler DeForest Edwards, B.A. College of City of New York.	*New York City,*	109 Elm st.
George Bronson Farnam, M.D.	*New Haven,*	86 Whitney av.
William Gamble, M.A.	*Shanghai, China,*	462 Chapel st.
Edward Gray, B.A.	*Benicia, Cal.*	106 Grove st.
Oscar Harger, M.A.	*Oxford,*	42 S. M.
Charles Sheldon Hastings, PH.B.	*Hartford,*	90 Grove st.
George W. Jones, M.A. Prof. in Iowa Agr. Coll.,	*Ames, Iowa.*	S. H.
Cassius William Kelly, B.A.	*Erie, Pa.*	163 York st.
Joseph Frederick Klein, PH.B.	*New Haven,*	86 Nicoll st.
Benjamin Kurtz, B.A. Pennsylvania College,	*Baltimore, Md.*	29 High st.
Charles Rockwell Lanman, B.A.	*Norwich,*	144 George st.
Thomas William Mather, PH.B.	*New Haven,*	26 Beers st.
Mansfield Merriman, PH.B.	*Plantsville,*	209 Elm st.
Charles Huntington Peck, B.A.	*New London.*	
George Bacheler Peck, M.D., M.A. Brown University,	*Providence, R. I.*	139 York st.
Daniel Hobart Pierpont, PH.B.	*North Haven,*	145 Olive st.
Herbert Edgar Smith, B.A. College of City of N. Y.	*Middletown,*	8 Lock st.
Charles Swan Walker, B.D.	*Darien,*	33 D. H.
Richard Chapman Weldon, M.A. Wesleyan Coll., Sackville, N. B.,	*Sussex, N. B.*	14 Lock st.
Henry Shaler Williams, PH.D.	*Ithaca, N. Y.*	246 Orange st.
Edward Allen Wilson, B.A.	*St. Louis, Mo.*	129 College st.

GRADUATES, 29.

SENIOR CLASS.

Jacob Jackson Abbott,	*Yarmouth, Me.*	29 Prospect st.
James Peter Bogart,	*New Haven,*	552 Chapel st.
William Darlington Evans,	*West Chester, Pa.*	462 Chapel st.
Joseph Ridgway Gawthrop,	*Northbrook, Pa.*	27 Mansfield st.
William Saunders Green,	*Cincinnati, O.*	165 Temple st.
George Wesson Hawes,	*Boston, Mass.*	90 Grove st.
Daniel Webster Hering,	*Johnsville, Md.*	8 Lock st.
Charles Louis Johnson,	*Ansonia,*	175 St. John st.
Samuel Trevor Knapp,	*New York City,*	23 Prospect st.
Harrison Wheeler Lindsley,	*New Haven,*	132 Olive st.
Frank Oscar Maxson,	*Norwich,*	8 Lock st.
Robert Douglass Milholland Maxwell,	*Wilmington, Del.*	23 Prospect st.
George Noyes Miller,	*Wallingford,*	104 Grove st.
Charles Theodore Morse,	*New Haven,*	151 York st.
Thomas Perkins Nevins,	*Waterford,*	96 York st.
Theophil Mitchell Prudden,	*New Haven,*	22 Clinton pl.
Thomas Hubbard Russell,	*New Haven,*	17 Wooster pl.
Charles Austin Tibbals,	*Brooklyn, N. Y.*	8 Lock st.
Daniel Wardwell Wardwell,	*Rome, N. Y.*	8 Lock st.
Frederick Floyd Weld,	*Guilford,*	165 Temple st.
William Brenton Welling,	*New York City,*	8 Lock st.

SENIORS, 21.

JUNIOR CLASS.

John Winthrop Auchincloss,	*New York City,*	116 High st.
Edgar Henry Summerfield Bailey,	*Middlefield,*	111 Court st.
Alvah Weed Brown,	*Englewood, N. J.*	25 Prospect st.
Harry Hill Buck,	*Orland, Me.*	S. H.
Moses Bulkley,	*Brooklyn, N. Y.*	29 Prospect st.
Charles Albert Burt,	*Wallingford,*	104 Grove st.
Fillmore Cogswell,	*Marble Dale,*	129 College st.
William Righter Comings,	*New Britain,*	27 Prospect st.
William Allen Cowles,	*New Haven,*	169 Temple st.
Charles Adams Cragin,	*Wallingford,*	104 Grove st.
Robert John Currey,	*San Francisco, Cal.*	122 College st.
Annis Merrill Doolittle,	*Wallingford,*	129 College st.
Harry Taylor Gause,	*Wilmington, Del.*	84 Wall st.
James Elliot Gregory,	*New York City,*	134 College st.
Edward Julius Hall,	*Buffalo, N. Y.*	177 Temple st.
Henry Sheaff Hoyt,	*Staatsburgh, N. Y.*	488 Chapel st.
Robert Jaffray,	*New York City,*	143 College st.
William Hampden Jenks,	*Brookville, Pa.*	22 York sq.
Charles Henry Matthews,	*Waterbury,*	25 Prospect st.
George Christopher Moore,	*Birmingham,*	15 Pine st.
Charles Miller Morse,	*Buffalo, N. Y.*	165 Temple st.
Charles Tombling Noonan,	*Milwaukee, Wisc.*	27 Prospect st.
William Josiah Parks,	*Brooklyn, N. Y.*	136 College st.
Walter Brewster Platt,	*Waterbury,*	109 Elm st.
Benjamin Pomeroy,	*Southport,*	122 College st.
Samuel Rockwell,	*Bridgehampton, N. Y.*	31 Prospect st.
Amory Edwards Rowland,	*Brooklyn, N. Y.*	29 Prospect st.
Edgar Camp Savage,	*West Meriden,*	177 Temple st.
William Lucien Scaife,	*Pittsburgh, Pa.*	25 Prospect st.
Alfred Lewis Sellers,	*West Chester, Pa.*	35 High st.
Charles Thompson Smith,	*New York City,*	25 Prospect st.
Edward Henry Smith,	*Plainville,*	135 Dwight st.
William Edward Smith,	*Goshen,*	498 Chapel st.
Lewis Rodney Taylor,	*Hamilton, Va.*	223 Crown st.
Aretas Whittelsey Thomas,	*Bethlehem,*	27 Prospect st.
Henry Goodrich Wolcott,	*Fishkill, N. Y.*	88 Wall st.

JUNIORS, 36.

FRESHMAN CLASS.

Thomas Belknap Beach,	*West Hartford,*	106 Wall st.
Moses Taylor Belcher,	*Garrison's, N. Y.*	35 High st.
Charles Cook Brewster,	*Norwich,*	33 Elm st.
Edward Brush,	*Greenwich,*	127 College st.
Edward Moses Child,	*Woodstock,*	136 Whalley av.
Arthur Bucklin Claflin,	*Boston, Mass.*	22 Trumbull st.
George Rufus Cooley,	*Hamden,*	104 Crown st.
Frederick Bowman Crawford,	*Chicago, Ill.*	33 Prospect st.
John Otis Davis,	*Hartford,*	149 College st.
Franklin Edwards,	*Northampton, Mass.*	107 York st.
Charles Howard Fitch,	*New Haven,*	58 Olive st.
Edwin Horace Forbes,	*Cromwell,*	8 Lock st.
William Hammond Franklin,	*Brooklyn,*	136 Whalley av.
LeRoy Gale,	*New York City,*	35 High st.
Jacob Grove,	*Fredericksburg, Pa.*	23 Prospect st.
Archie Smoote Hall,	*Mobile, Ala.*	94 Grove st.
Vincent Gilpin Hazard,	*West Chester, Pa.*	120 College st.
Frazier Davenport Head,	*St. Paul, Minn.*	94 Grove st.
Charles Daniel Hill,	*Calais, Me.*	64 Whitney av.
Frank Leroy Holt,	*Rockville,*	23 Lyon st.
Irving Lucius Holt,	*Meriden,*	23 Lyon st.
Allen Brewer Howe,	*Troy, N. Y.*	138 College st.
Henry Hun,	*Albany, N. Y.*	416 Chapel st.
Henry Jarvis Kellogg,	*Milford,*	131 York st.
William Henry Kellogg,	*Chicago, Ill.*	22 Trumbull st.
Charles Hittell Killinger,	*Lebanon, Pa.*	173 Temple st.
Beverly Livingston,	*Garrison's, N. Y.*	145 York st.
William Pitt Lynde,	*Milwaukee, Wisc.*	161 George st.
William McGrath,	*Bridgeport,*	498 Chapel st.
Thomas Massie,	*Charlottesville, Va.*	202 York st.
Charles James Morse,	*Poland, O.*	46 Hillhouse av.
George Smith Needham,	*Louisville, Ky.*	106 Grove st.
Harry Gregory Newhall,	*San Francisco, Cal.*	8 Elm st.
Eugene Ernest Osborn,	*Norwalk,*	81 Howe st.
Richard Deane Arden Parrott,	*Greenwood Works, N. Y.*	88 Wall st.
Claudius Victor Pendleton,	*Bozrah,*	8 Lock st.
Andrew Peters,	New York City,	189 C.

Frank Plume,	*Thomaston,*	149 College st.
George Coffin Power,	*Hudson, N. Y.*	15 Home pl.
William Spencer Pratt,	*New Haven,*	17 Hazel st.
William Henry Reynolds,	*New Haven,*	129 York st.
Nelson Robinson,	*New York City,*	15 s.
William Rockwell,	*Bridgehampton, N.Y.*	33 Prospect st.
William Rodman,	*New Haven,*	491 Chapel st.
William Arthur Rogers,	*Covington, Ky.*	217 Crown st.
Charles Waterman Smith,	*Hartford,*	90 Grove st.
William von Steinwehr,	*New Haven,*	117 Elm st.
John Muirhead Stewart,	*Peekskill, N. Y.*	104 Crown st.
Francis Hill Stillman,	*Westerly, R. I.*	8 Lock st.
Jared Sidney Torrance,	*Gowanda, N. Y.*	33 Prospect st.
William Richardson Upham,	*Yonkers, N. Y.*	92 Grove st.
Simeon Harrison Wagner,	*Morris,*	104 Crown st.
John Charles Weber,	*New York City,*	23 Prospect st.
Charles Bell Willcox,	*Stamford,*	172 George st.
George Egbert Wright,	*Newburgh, N. Y.*	33 Eld st.

FRESHMEN, 55.

SPECIAL STUDENTS NOT CANDIDATES FOR A DEGREE.

Bernard Nadal Baker,	*Baltimore, Md.*	31 Prospect st.
Henry Fowler English,	*New Haven,*	134 Chapel st.
Philip Owen Hawkins,	*Wakefield, R. I.*	505 Chapel st.
Lorenzo M. Johnson,	*Rochester, Mass.*	16 Grove st.
Archibald McCall,	*West Chester, Pa.*	177 Temple st.
George Soulé Phelps,	*East Windsor,*	Wallingford.
William James Rattle,	*Cleveland, O.*	96 York st.
Archibald Rogers,	*New York City,*	120 College st.

SPECIAL STUDENTS, 8.

SUMMARY.

GRADUATES,	29
SENIORS,	21
JUNIORS,	36
FRESHMEN,	55
SPECIAL,	8
TOTAL,	149

SHEFFIELD SCIENTIFIC SCHOOL.

I.

Objects.

The Sheffield Scientific School is devoted to instruction and researches in the mathematical, physical, and natural sciences, with reference to the promotion and diffusion of science, and also to the preparation of young men for such pursuits as require especial proficiency in these departments of learning. It is one of the Departments of Yale College, like the law, medical, theological and art schools, having its separate funds, building, teachers, and regulations, but governed by the Corporation of Yale College, which appoints the professors and confers the degrees. It is, in part, analogous to the academic department or classical college, and, in part, to the professional schools. It affords no easy path to an academic degree, but offers to those who desire to become thoroughly educated in scientific studies, the opportunity for efficient training, under a large corps of teachers, and with ample apparatus, books, collections, and other facilities for study.

The instructions are accordingly designed to be advanced, systematic, and thorough. The wants of two classes of scholars are continually borne in mind:—

I. The graduates of this or of other colleges, and other persons who have prepared themselves for advanced scientific pursuits. Every endeavor is put forth to meet the wants of those who desire to become proficient in some specialty, or who wish to pursue a systematic course of instruction with reference to scientific culture. To this class of students much greater freedom is permitted than to the undergraduates.

II. The undergraduates, who may be preparing themselves by a course of training, chiefly mathematical and scientific, and partly linguistic, for higher scientific studies, or for such occupations as call for an accurate knowledge of some branches of modern science, as a condition of success. Undergraduates, after the first year, *select* one of several prescribed courses, and then follow strictly *the scheme* therein laid down.

II.

History and Organization.

The School was commenced in 1847. In 1860, a convenient building and a considerable endowment were given by Joseph E. Sheffield, Esq., of New Haven, whose name, at the repeated request of the Corporation of Yale College, was afterward attached to the foundation. Mr. Sheffield has frequently and munificently increased his original gifts, and has already begun the construction of an additional building for the use of the School.

In 1864, by an act of the Connecticut Legislature, the national grant for the promotion of scientific education (under the Congressional enactment of July, 1862) was given to this department of Yale College, which thus became "the Connecticut College of Agriculture and the Mechanic Arts." Since that time, and especially since the autumn of 1869, numerous liberal gifts have been received from the citizens of New Haven, and from other gentlemen in Connecticut, New York, and St. Louis, for the endowment of the School, and the increase of its collections.

The action of the State led to the designation by law of a State Board of Visitors, consisting of the Governor, Lieutenant Governor, three senior Senators, and Secretary of the State Board of Education; and this Board, with the Secretary of the Scientific School, is also the Board for the appointment of students to hold the State scholarships.

As an additional means of acquainting the public with the work of the school, and securing for it greater success, the Corporation of Yale College has appointed a Board of Councillors, consisting of some of the gentlemen who have manifested, in different ways, a deep and permanent interest in the welfare of the institution.

The Governing Board consists of the President of Yale College and the Professors who are permanently attached to the School. There are several other instructors associated with them, a part of whom are connected with other departments of the College.

This peculiar organization, though somewhat complex, has been a natural growth of the last twenty-five years, and it may be added that the combination of a new department, with an old and well tried institution like Yale College, has advantages for both. The establishment of a college of science has relieved the academic or classical college from all pressure tending to the establishment of "*partial courses*" of study, and has supplemented its

means of instruction by new professorships and new scientific collections; while it has rendered further service by giving to graduates of the classical department, opportunities for special and systematic professional training, distinct from those afforded in the schools of law, medicine, and theology.

On the other hand, the Scientific School has had the benefit of the name and repute of Yale College throughout the land. The long-established libraries and cabinets have been opened to the scientific students, who have also attended many courses of the academic lectures. More than all this, many of the officers of the classical college, by their influence, encouragement, and counsel, have given and are constantly giving to the new college assistance too valuable and enduring to be ever forgotten.

Under these circumstances, it may be well to add that during the wide-spread controversy between science and letters as means of instruction, the utmost harmony has prevailed in New Haven among the friends of both.

III.

Building and Apparatus.

Sheffield Hall is a large and well arranged building, containing recitation and lecture rooms for all the classes, a hall for public assemblies and lectures, chemical and metallurgical laboratories, a photographical room, an astronomical observatory, museums, a library and reading room, besides studies for some of the professors, where their private technical libraries are kept.

The following is a summary statement of the collections belonging to the School:—

1. Laboratories and Apparatus in Chemistry, Metallurgy, Photography, and Zoölogy.
2. Metallurgical Museum of Ores, Furnace Products, etc.
3. Agricultural Museum of Soils, Fertilizers, useful and injurious Insects, etc.
4. Collections in Zoölogy.
5. Astronomical Observatory, with an equatorial telescope by Clark and Sons of Cambridge, a maridian circle, etc.
6. Library and reading room, containing the "Hillhouse Mathematical Library," books of reference, and a selection of German, French, English, and American scientific journals.
7. A collection of Physical Apparatus, constituting the "Collier Cabinet"—recently purchased.
8. Models in Architecture, Geometrical Drawing, Civil Engineering, Topographical Engineering, and Mechanics; diagrams adapted to public lectures; instruments for field practice.
9. *Maps* and Charts, topographical, hydrographical, geological, etc.

The mineralogical cabinet of Professor Brush, the herbarium of Professor Brewer, the collection of native birds of Professor Whitney, and the astronomical instruments of Professor Lyman, are deposited in the building. Professor Eaton's herbarium, near at hand, is freely accessible.

Students are also admitted, under varying conditions, to the College and Society libraries, the College Reading Room, the Cabinet of Minerals and Fossils, the School of the Fine Arts, and the Gymnasium.

IV.

Instruction for Graduate Students.

One of the principal objects of this department, since its foundation, has been to afford to young men of superior qualifications the opportunity of pursuing advanced studies in science. Graduates of this and other colleges are received without examination, upon the testimonial of their diplomas that they have honorably completed their preliminary courses. They may remain, at their option, for one year or for several years, and may study with or without reference to the attainment of a second degree.

The very different requirements of such students render it difficult to state in precise terms what facilities are here afforded. In some cases, particularly in the mathematical studies, the student will join that class for which his previous mathematical work has prepared him; in other cases, as in the chemical laboratory and in the study of Natural History, every scholar will pursue an independent course of research according to his capacity and the time he can devote to such a specialty. In any case, the student who desires to pursue such advanced courses is invited to apply in person or by letter to the professor in whose department he is most interested, and thus ascertain what arrangements can be effected. When three or four persons of similar acquirements desire like opportunities, it will often be easier to mark out for them a schedule of work.

During the last few years, there have been annually between twenty and thirty graduate students in the Sheffield School. The call for persons of advanced scientific attainments has never been so frequent as now; and the opportunities for future usefulness and culture have never been so inviting.

Great freedom of choice in respect of work is allowed to the graduate students, and in accordance with their requirements, the libraries, collections, and instruments are freely at their service.

As examples of what may be done in Mathematics, Physics, and Astronomy, it may be mentioned that Professors NORTON, TROWBRIDGE, and LYMAN, with the coöperation of Professor H. A. NEWTON, will direct the studies of those who wish to avail themselves of the class instructions in the Calculus, in Analytical and Descriptive Geometry, Mathematical Drawing, Practical Astronomy, etc. The Hillhouse Mathematical Library is open for consultation daily, and the equatorial telescope, meridian circle, and other astronomical instruments belonging to the School, may be freely used by advanced students.

The Chemical Laboratory is fitted for the instruction of those who wish to become proficients in practical analysis, either in preparation for professorships, technical pursuits, the medical profession, or other purposes. Professors JOHNSON, BRUSH, and ALLEN will direct the studies in higher Chemistry, Mineralogy, and Metallurgy.

Instruction in Natural History may be received from Professors VERRILL and MARSH in the Zoölogical Laboratory, where the collection, description, and classification of specimens are continually in progress; or by private arrangement in the herbarium of Professor EATON. The public and private collections of Minerals, Ores, Fossils, etc., afford special facilities for the study of Mineralogy and Geology.

V.

INSTRUCTION FOR UNDERGRADUATE STUDENTS.

TERMS OF ADMISSION.—Candidates must be not less than sixteen years of age, and must bring satisfactory testimonials of moral character from their former instructors or other responsible persons.

For admission the student must pass a thorough examination in Davies's Bourdon's *Algebra* as far as the General Theory of Equations, or in its equivalent; in *Geometry*, in the nine books of Davies's Legendre, or their equivalent; and in *Plane Trigonometry*, Analytical Trigonometry inclusive; and also in *Arithmetic*, including the "Metric System," *Geography*, *United States History*, and *English Grammar*, including Spelling. An acquaintance with the *Latin* language is also required, sufficient to read and construe some classical author, and Allen's Latin Grammar is commended as exhibiting the amount of grammatical study deemed important. Practice in *Drawing*, if it can be obtained before entrance, will be of great advantage.

The examinations for admission take place at Sheffield Hall, on the Friday (July 12, 1872) after Commencement, at 9 A. M., and nine weeks later, on that Wednesday in September (Sept. 11, 1872) on which the Fall Term begins. Opportunity for private examination may, in exceptional cases, be given at other times.

Candidates for advanced standing in the undergraduate classes are examined, in addition to the preparatory studies, in those already pursued by the class they propose to enter. No one can be admitted as a candidate for a degree after the commencement of the Senior year.

VI.

COURSES OF INSTRUCTION,

Occupying three years, are arranged to suit the requirements of various classes of students. The first year's work is the same for all; during the last two years the instruction is chiefly arranged in special courses.

The special courses most distinctly marked out are the following:—

(a.) In Chemistry and Metallurgy;
(b.) In Civil Engineering;
(c.) In Dynamical (or Mechanical) Engineering;
(d.) In Agriculture;
(e.) In Natural History;
(f.) In studies preparatory to Medical Studies.
(g.) In studies preparatory to Mining;
(h.) In Select studies preparatory to other higher pursuits, to business, etc.

The arrangement of the studies is indicated in the annexed scheme.

FRESHMAN YEAR.—INTRODUCTORY TO ALL THE COURSES.

FIRST TERM.—*German*—Whitney's Grammar and Reader. *English.*—Hadley's Brief History of the English Language; Exercises in Composition. *Mathematics.*—Davies's Analytical Geometry, and Spherical Trigonometry. *Physics.*—Atkinson's Ganot, with experimental lectures. *Chemistry.*—Eliot and Storer's Manual; Laboratory practice. *Elementary Drawing.*—Practical Lessons in the Art School. *Laws of Health.*—Lectures by Professor F. BACON.

SECOND TERM.—*Language, Physics, Chemistry, and Drawing.*—As stated above. *Mathematics.*—Church's Descriptive Geometry. *Elocution.*

THIRD TERM.—*Mathematics.*—Surveying and Plotting. *Botany.*—Gray's Lessons. *Physical Geography.*—Ten Lectures on the Outlines of the Structure of the Earth. Other studies continued. *Drawing.*—Binn's Orthographic Projection.

For the Junior and Senior years the students select for themselves one of the following courses:

(a.) IN CHEMISTRY AND METALLURGY.

JUNIOR YEAR.

FIRST TERM—*Theoretical and Organic Chemistry.*—Lectures. *Chemical Analysis.*—Fresenius. Use of Blow-pipe. *Laboratory Practice.*—Qualitative Analysis. *English. German. French.*

SECOND TERM—*Laboratory Practice.*—Qualitative Analysis, continued. Quantitative Analysis, begun. *Zoölogy.*—Lectures. *English. German. French.*

THIRD TERM—*Mineralogy.*—Dana. Lectures and Practical exercises. *Organic Chemistry.*—Lectures. *Zoölogy.*—Lectures and Excursions. *Laboratory Practice.*—Quantitative Analysis, continued. *English and French*—continued.

SENIOR YEAR.

FIRST TERM—*Metallurgy.*—Percy. Lectures. *Geology.*—Dana. Lectures and Recitations. *Zoölogy.*—Lectures. *Laboratory Practice.*—Volumetric and Organic Analysis. *Determinative Mineralogy. English and French*—continued.

SECOND AND THIRD TERMS.—*Metallurgy.*—Lectures. *Agricultural Chemistry.*—Recitations and Lectures. *Geology.*—Dana. *Laboratory Practice.*—Mineral Analysis and Assaying. *Determinative Mineralogy. English and French*—continued.

(b.) IN CIVIL ENGINEERING.

JUNIOR YEAR.

FIRST TERM—*Mathematics.*—Analytical Geometry of Three Dimensions. Church's Differential Calculus. Church's Descriptive Geometry, continued. *Surveying.*—Topographical and Hydrographic. *Drawing.*—Plotting, and Chart Drawing. *English, French, and German.*

SECOND TERM—*Mathematics*—Differential and Integral Calculus. *Astronomy.*—Norton's Astronomy, with practical problems. *English, French, and German.*

THIRD TERM—*Mechanics.*—Peck's Elements. *Surveying.*—Topographical. Topographical sketching in the field. *Drawing.*—Binn's Second Course of Orthographic Projections. Linear Perspective. Isometrical and Topographical Drawing. *English and French.*

SENIOR YEAR.

FIRST TERM—*Field Engineering.*—Laying out curves. Location of line of Railroad, with calculations of excavation and embankment. Henck's Field Book for Railroad Engineers. *Stone Cutting*—with graphical problems. *Mechanics.*—Application of Calculus to Mechanics. Mechanics applied to Engineering. *Geology.*—Dana. *Drawing.*—Binn's Second Course. *English and French.*

SECOND TERM—*Civil Engineering.*—Mahan's. Building Materials (Lectures). *Strength of Materials.* Bridge Construction. *Surveying*—with Plane Table. *Geodesy. Drawing.*—Mechanical and Architectural. English and French.

THIRD TERM—*Civil Engineering.*—Bridge Construction, continued. Stability of Arches and Walls. *Dynamics.*—Principles of Mechanism. Steam Engine. *Hydraulics.*—Theory of Turbines and other Water Wheels. Bennett's D'Aubuisson's Hydraulics. *Drawing.*—Structural.

Students pursuing a higher course in Engineering, for one year after graduating as Bachelors, may receive the degree of Civil Engineer.

(c.) IN MECHANICAL ENGINEERING.

JUNIOR YEAR.

Pure Mathematics.—Descriptive Geometry, with applications. Geometry of Machinery. Analytical Geometry of Three Dimensions. Differential and Integral Calculus. *Mechanics.*—Analytical Mechanics. Principles of Mechanism. *Drawing.*—Binn's Orthographic Projections. Elements of Mechanical Drawing and Principles of Construction. Shading and Tinting, and drawing from Patterns. *Metallurgy. English, French, and German.*

SENIOR YEAR.

Applied Mechanics.—Strength of Materials. Thermo-dynamics. Theory and Construction of the Steam Engine and other prime movers. Theory of Machines. Mill work. Examination of Machinery. Mechanical Construction. Use of tools. *Drawing.*—Drawing from actual Machines. Designs of Machines. *English, French, and German.*

(d.) IN AGRICULTURE.

JUNIOR YEAR.

FIRST YEAR.—*Theoretical and Organic Chemistry.*—Lectures. *Experimental and Analytical Chemistry*—in their Agricultural applications. Laboratory practice. *French*—begun. *German*—continued.

SECOND YEAR—*Agricultural Chemistry.*—Recitations.—*Experimental Chemistry.*—Laboratory practice. *French and German*—continued. *Physical Geography.*—Lectures. *Zoölogy.*—Lectures.

THIRD TERM—*Agricultural Chemistry.*—Lectures. *Horticulture and Kitchen Gardening.*—Lectures. *Mineralogy.*—Lectures and Practical Exercises. *Zoölogy.*—Lectures. *Experimental Chemistry.*—Laboratory practice. *French*—continued. *Drawing.*—Free-hand practice. *Excursions.*—Botanical, Zoölogical, etc.

SENIOR YEAR.

FIRST TERM—*Agriculture.*—Cultivation of the Staple Crops of the Northern States. Lectures. *Agricultural Zoölogy.*—Origin and Natural History of Domestic Animals. Insects useful and injurious to Vegetation. Lectures. *Geology.*—Dana's Manual. *French*—continued. *Excursions.*—Agricultural, Zoölogical, Geological, etc.

SECOND TERM—*Agriculture.*—Stock-raising and principles of Breeding. Lectures. *Forestry.*—Preservation, culture, and use of Forests and Forest Trees. Lectures. *Human Anatomy and Physiology.*—Lectures. *French*—continued.

THIRD TERM—*Rural Economy.*—History of Agriculture and Sketches of Husbandry in Foreign Countries. Adaptation of farming to soil, climate, market, and other conditions. Systems of Husbandry. Stock, sheep, grain, and mixed farming. Lectures. *Excursions*—Agricultural, Geological, Zoölogical, and Botanical.

(e.) NATURAL HISTORY.

(Either Geology, Mineralogy, Zoölogy, or Botany may be made the principal study, some attention in each case being directed to the other three branches of Natural History.)

JUNIOR YEAR.

FIRST TERM—*Zoölogy.*—Daily Laboratory instruction; Zoölogical Excursions. *Botany.*—Gray's Text-Book; Use of the Microscope. *Chemistry.*—Theoretical and Organic Chemistry. *French*—begun. *German*—continued.

SECOND TERM—*Zoölogy and Palæontology.*—Laboratory practice. Lectures. *Botany.*—Lectures; Gray's Text-Book. *Physical Geography.*—Lectures and Recitations. *Chemistry*—Laboratory practice. *French and German*—continued.

THIRD TERM—*Zoölogy and Palæontology.*—Laboratory practice. Lectures, Excursions (land and marine). *Botany.*—Excursions. Practical exercises. Gray's Manual. *Mineralogy.*—Dana. Lectures. Practical exercises. *French*—continued. *Drawing*—Free-hand practice.

SENIOR YEAR.

FIRST TERM—*Language.*—Whitney's Language and the Study of Language. *French.*—Selections. *Zoölogy and Palæontology.*—Laboratory practice. Lectures. Excursions. *Botany.*—Excursions. Herbarium studies. *Geology.*—Dana's Manual. Excursions.

SECOND TERM.—*Zoölogy and Palæontology*—continued. *Botany*—Herbarium studies. Botanical Literature. Essays in Descriptive Botany. *Geology.*—Dana. Lectures. *Anatomy and Physiology.*—Academical Lectures. *French.*—Selections. *Whitney on Language*—continued.

THIRD TERM.—*Zoölogy, Botany, and Palæontology*—continued, with Excursions. *Photography.*—Practical instruction.

Besides the regular courses of lectures on structural and systematic Zoölogy and Botany, and on special subjects, students are taught to prepare, arrange and identify collections, to make dissections, to pursue original investigations, and to describe Genera and Species in the language of science. For these purposes, large collections in Zoölogy and Palæontology belonging to the College are available, as are also the private botanical collections of Professor Eaton.

(f.) IN PREPARATION FOR MEDICAL STUDIES.

During the Junior year, the work of this course will be chiefly under the direction of the instructors in Chemistry. Especial attention will be given to qualitative and quantitative analysis, *in their* physiological and medical bearings, and to the prepara-

tion and study of the organic proximate elements. In the Senior year, the work will be chiefly under the direction of the Professors of Zoölogy and Botany. Attention will be paid in Zoölogy to comparative anatomy, reproduction, embryology, the laws of hereditary descent, and human parasites; and in Botany to a general knowledge of structural and physiological Botany, and to medicinal, food-producing, and poisonous plants. The studies of the Select Course in Physical Geography, History, English Literature, etc., are followed by these students.

(g.) IN STUDIES PREPARATORY TO MINING.

Young men desiring to become Mining Engineers, can pursue the regular course in Civil or Mechanical Engineering, and at its close can spend a fourth year in the study of metallurgy, mineralogy, etc. Should there be a sufficient number of students desiring it, a course of lectures on the subject of Mining will also be provided.

(h.) IN SELECT STUDIES PREPARATORY TO OTHER HIGHER PURSUITS, TO BUSINESS, ETC.

JUNIOR YEAR.

FIRST TERM.—*German*, *English*, *Mathematics*, *Drawing*—continued. *French*—begun. Lectures and Exercises in Chemistry, Mineralogy, and the Physical Geography of Europe.

SECOND TERM.—*German*, *French*, *English*—continued. *Astronomy*.—Norton's Astronomy, with practical problems. *Modern History*.—Recitations and Lectures.

THIRD TERM.—*French and English*—continued. *Mechanics*.—Peck's Elements. *Botany and Zoölogy*.—Lectures and Excursions.

SENIOR YEAR.

LANGUAGE.—The study of French and English are continued through the year, and during the first two terms there are recitations in Whitney's Language and the Study of Language.

NATURAL SCIENCE.—The study of Geology is pursued by recitations, lectures and excursions. Lectures are given in Rural Economy and the Principles of Agriculture, and also in Agricultural Chemistry. Botany is studied during the early part of the autumn term.

HISTORY, GEOGRAPHY, AND POLITICAL PHILOSOPHY.—Lectures, Recitations, and Exercises will be continued through the year.

The writing of Compositions is required during the entire course from all the students. During the Senior year, the preparation of the thesis occupies the attention of the class.

Lectures on *Military Science* and Tactics are annually given.

VII.

Instruction for Special Students.

For the benefit of those who desire to pursue some particular studies without reference to a college degree, most of the various instructors are willing to receive special students for a longer or shorter time.

It should be distinctly understood that these opportunities are not offered to persons who are incompetent to go on with regular courses, but are designed to aid those who have been educated elsewhere to increase their proficiency in special branches.

VIII.

Lectures.

The instructions of this institution are given chiefly in small class rooms, by recitations or familiar lectures, illustrated by the apparatus at the command of the various teachers. A public course of lectures is given every winter on topics of popular interest. On Sunday evenings during a portion of the year, lectures are given by resident clergymen of different denominations, and by members of the Theological and other college faculties. A course of lectures on the Preservation of Health, by Dr. Francis Bacon, Professor in the Medical Department, may be expected on Saturday mornings at the beginning of the autumn term.

IX.

Tuition Charges.

The tuition charge is $150 per year. Besides this there is a charge of $5 annually for the use of the academical reading room and gymnasium. Freshmen pay $5 for chemicals; and the special students in the chemical laboratory are likewise charged $25 per term for the materials they use—besides breakage. The Graduation fee is $10.

X.

Church Sittings.

Free sittings for students in this department of Yale College are provided as follows:

In the Center Church (Cong.), Rev. G. L. Walker, D.D.: Pews No. 36 and 42, in the North Gallery.

In Trinity Church (Episc.), Rev. E. Harwood, D.D.: Pews No. 175 and 177, in the North Gallery.

In the First Methodist Church, Rev. G. W. Woodruff, D.D.: Pew No. 78, at the head of the West Aisle (below).

Any of the students may occupy a sitting in these slips. Those who prefer to pay for a sitting for a year, more or less, in the churches above mentioned, or in any other church of any denomination, will be aided on application to the Treasurer or Secretary of the School.

Sittings in the Gallery of the College Chapel are free as heretofore to the students of this department.

XI.

Degrees.

Students of this department, on the recommendation of the Governing Board, are admitted by the Corporation of Yale College to the following degrees. They are thus conferred:

1. Bachelor of Philosophy: on those who complete any of the three-year courses of study, passing all the examinations in a satisfactory manner, and presenting a graduation thesis.

The fee for graduation as Bachelor of Philosophy, including the fee for Triennial Catalogues, Commencement Dinners, etc., is ten dollars; unless the person taking the degree is also an academical graduate, when it is but five dollars.

2. Civil Engineer: on students of a higher course (occupying one year), who have sustained the final examination, and given evidence of their ability to design important constructions and make the requisite drawings and calculations. The fee for this degree is five dollars.

3. Doctor of Philosophy: on Bachelors of Arts, Science, and Philosophy, on the following conditions: Bachelors of Arts desiring to be admitted to this degree must remain in New Haven at

least two academic years after receiving their first degree, during which they must faithfully engage in a course of study selected, with the approval of the Faculty, from branches pursued in this department. Graduates of institutions having an undergraduate course of three years only, can be admitted to this degree only after *three* years of post-graduate study.

At the close of the course the candidate must pass a satisfactory examination, and present a thesis giving evidence of high attainment in the studies to which he has attended. Except in extraordinary cases, and by a special vote of the Faculty, no one will be admitted to this degree without a knowledge of French and German; nor without so much knowledge of Latin as is acquired by the end of the Freshman year in the Academical Department.

The fee for the degree is ten dollars.

XII.

Terms and Vacations.

The next academic year begins Thursday, September 12, 1872. Examinations for admission, Friday, July 12, and Wednesday, Sept. 11. The vacations coincide with those of the academic department, giving two weeks holidays at Christmas, two weeks in the spring and eight weeks (or sometimes nine) in summer.

XIII.

Explanation of some of the Studies.

In explanation of some of the studies which are pursued by the Select Course students, and are more or less attended by the students of other courses, the following statements are given. Post-graduate students may, at their option, attend the exercises here referred to, when the hours do not interfere with their other specialties.

Botany.

The study of Botany begins in the summer of Freshman year, with recitations from Gray's Lessons on Structural and Physiological Botany, illustrated by examples from Nature.

In the summer of Junior year, exercises in analysing and identifying plants occur two or three times a week, followed by practice in writing characters and descriptions of plants from living *specimens*. Students are shown also how to collect and preserve *specimens* for future use, several Natural Orders being especially

indicated to each class for special work in collecting. Excursions every Wednesday.

In the autumn term of Senior year, the work of the summer is continued. Students will now begin to write generic as well as specific characters, and at the close of the term an essay on some one Natural Order will be required. During the second and third terms, a Herbarium of the indicated Natural Orders will be prepared, and presented for examination at the end of the year.

In the same terms a course of lectures on Botany is given to the Senior Class of the Academical Department, and the Seniors of the Select Course are expected to attend these lectures.

Zoölogy.

The instruction in Zoölogy consists of the following courses:

a. In the second term of the Junior year, a course of lectures on Comparative Anatomy and Physiology, and the Principles of Zoölogy. The students are required to take notes, and are questioned at the beginning of each lecture upon subjects of the previous one.

b. During the third term of the Junior year, a course of lectures upon systematic Zoölogy, including the structure, classification, metamorphoses, and habits of animals. This course is intended partly as a preparation for Geology.

c. Weekly excursions during the third term of Junior and first term of Senior year, in company with the instructors, for the purpose of observing the habits and making collections of marine, fresh-water, and terrestial animals of all classes. Each student is required to prepare and present for examination a collection containing a specified number of species, and illustrating the various classes of animals. He must also be able to pass an examination upon his collection, at least to the extent of explaining the classes illustrated, and showing why particular specimens belong to their respective classes.

d. During the first term of the Senior year, lectures on various special subjects, such as Domestic Animals, the Laws of Reproduction and Breeding, Embryology, Theories of Evolution, Geographical Distribution, Applied Entomology.

Geology.

The instruction in Geology is as follows:

a. During the first and second terms of the Senior year, recitations *three times a week* in Dana's Manual, illustrated by numer-

ous specimens of minerals, rocks, and fossils, and also diagrams and charts.

b. Excursions into the country in the first term to examine Geological phenomena, and to see the rocks in place.

c. Frequent visits to the Geological collections in company with the instructor, for the purpose of seeing larger series of fossils than can be exhibited in the class room.

Physical Geography.

In the third term of Freshman year, a course of ten or twelve lectures, with questions and drill upon the maps, will be given, as an introduction to Physical Geography and a review of elementary studies. These exercises will chiefly relate to the globe in its entirety, and to the separate continents.

In the Junior year, the study of a text book will be followed with illustrative lectures, and practical lessons upon the globe and in topographical drawing.

In the Senior year, the careful study of the continents of Europe and North America will be taken up, chiefly with reference to their physical peculiarities, but with an incidental regard to national progress.

XIV.

LATIN.

The requirement of a certain amount of Latin as preparation for entrance into the Sheffield Scientific School causes so many inquiries that a few words of explanation of its nature and purpose seem called for.

First, as regards its reason. This is partly the intrinsic value of the Latin itself, partly its value as a preparation for other studies pursued in the School. That its acquisition is of great practical importance to educated men in every department is obvious. Were it only that almost all scientific nomenclature and phraseology is founded upon it, this would be reason enough for its inclusion among the studies of scientific men. An additional reason is that so much of our ordinary English speech is also of Latin origin. A man can no more claim to have enjoyed a fairly liberal education—an education that shows him the foundation and relations of things, and gives him command of useful instru-

ments for further knowledge—without Latin than without German or French.

The language studies pursued in the School are mainly German and French. As things are at present in the preparatory schools, we are obliged to commence work upon those two languages with the very rudiments. But we need something that shall give our pupils a degree of practice and facility in taking hold of a strange language, in order to bring them to those others with a certain preparation, and enable them to make more rapid and equal progress. Nothing in this way is so useful as a little thorough training in the Latin grammar and in Latin translation. Moreover, this training is more universally and readily accessible than any other. The text-books are all that could be desired, and every good school, and almost every community outside the School, furnishes teachers who are qualified to help the beginner. And even if such helps were wanting, no capable and energetic young man need be afraid to take up a Latin grammar, and master by himself enough of it to begin reading.

As to the amount, we do not venture yet to require much—only the essential parts of the grammar, and ability to read and construe with intelligence some Latin author, such as Cæsar, or Virgil, or Sallust, or Cicero; this can be learned without difficulty by making the study one of those pursued through the year before entering; or even, with energy, in a shorter time.

But while we at present require little, we recommend a good deal more. The more a pupil learns of Latin the better he is off. When the School grows stronger, a continuance of this study will be a regular part of the course, at least for those having in view medicine or the natural sciences—as, indeed, it has been made in some degree already.

XV.

ANNOUNCEMENT IN RESPECT TO STATE STUDENTS.

The scholarships established in this School in consequence of the bestowal upon it of the Congressional grants are designed to aid young men who are in need of pecuniary assistance in fitting themselves for agricultural and mechanical pursuits of life. All applicants must be citizens of Connecticut. In case there are more applicants than vacancies, candidates will be preferred who have lost a parent in the military or naval service of the United States, and the appointments will be distributed as fas as practicable

among the several counties in proportion to their population. The Appointing Board for the current year, consisting of the Board of Visitors of the State and the Secretary of the School, will meet on Monday, July 8, 1872, and at about the same time in the year 1873, due notice of which will be given by a publication in every county of the State. All applications should be made previous to that time. Blank forms for application will be sent, when requested, by Professor DANIEL C. GILMAN, Secretary of the Appointing Board.

XVI.

ANNIVERSARY.

The Annual Meeting of the State Board of Visitors occurs in the second term.

The Anniversary of the School is held on Monday of the Commencement week in Yale College, July 8, 1872, when selections from the graduation theses are publicly read. The degrees are publicly conferred by the President and Fellows of Yale College on Commencement Day.

XVII.

PARTIAL SCHEDULE OF HOURS.

FRESHMAN YEAR.

First Term.

	MORNING.	NOON.	AFTERNOON.
M.	German.	Analytical Geometry.	Chemistry.
T.	Physics.	"	"
W.	German.	Free-hand Drawing.	———
Th.	Physics.	Analytical Geometry.	Laboratory Pract. or English.
F.	German.	"	" "
S.	Physics.	Free-hand Drawing.	———

During the first half of the term, lectures on Health on Saturday mornings. Through the term, one lecture weekly on Physics.

Second Term.

M.	German.	Descr. Geometry and Spherics.	Chemistry.
T.	Physics.	" "	"
W.	German.	Free-hand Drawing.	———
Th.	Physics.	Descr. Geometry and Spherics.	Labor. Practice or English.
F.	German.	" "	" "
S.	Physics.	Free-hand Drawing.	———

The English lessons include a course of lessons in Elocution. The lectures in Physics are continued.

Third Term.

M.	German.	Physics.	Surveying and Plotting; and
T.	Physics.	Botany.	Binn's FirstCourse in Drawing.
W.	German.	English.	
Th.	Physics.	Botany.	
F.	German.	Physics.	
S.	Physics.	Phys. Geog. (10 lectures.)	

JUNIOR YEAR. (SELECT COURSE.)

First Term.

M.	French.	Mineralogy.	English.
T.	German.	"	"
W.	French.	Theor. and Org. Chem.	———
Th.	German.	" "	English.
F.	French.	Physical Geography.	"
S.	German.	"	———

The noon exercises, except on Monday, will be lectures, and the interval between them and the early morning recitation will be set apart for Free-hand Drawing.

Second Term.

	MORNING.	NOON.	AFTERNOON
M.	French.	Astronomy.	English.
T.	German.	"	"
W.	French.	"	———
Th.	German.	"	Physical Geography.
F.	French.	"	" "
S.	German.	———	———

Saturday morning is given up to the reading of Essays and to lectures on Zoölogy. Free-hand drawing is also continued.

Third Term.

M.	Mechanics.	Zoölogy.	French.
T.	"	Botany.	"
W.	"	Zoölogy.	Scientific Excursions.
Th.	"	Botany.	French.
F.	"	Zoölogy.	English.
S.	"	Botany.	———

SENIOR YEAR.* (SELECT COURSE.)

First Term.

M.	Geology.	Linguistics.	Modern History.
T.	French.	"	"
W.	Geology.	Zoölogy.	———
Th.	French.	English.	Modern History.
F.	Geology.	"	"
S.	French.	Zoölogy.	———

Second Term.

M.	Geology.	Linguistics.	Modern History.
T.	French.	"	"
W.	Geology.	English.	———
Th.	French.	Agricultural Chemistry.	Agriculture.
F.	Geology.	" "	"
S.	French.	English.	———

Third Term.

M.	English.	Political Economy.	Rural Economy.
T.	"	" "	" "
W.	"	" "	———
Th.	"	" "	Meteorology.
F.	"	Agricultural Chemistry.	"
S.	"	" "	———

* The preparation of a thesis occupies a part of the second and third terms The Academic Lectures on Human Anatomy and some of the lectures of President Porter are attended by the class.

EIGHTH

ANNUAL REPORT

OF THE

Sheffield Scientific School

OF

YALE COLLEGE.

1872–3.

PRINTED BY ORDER OF THE GENERAL ASSEMBLY.

NEW HAVEN:
PRINTED BY TUTTLE, MOREHOUSE & TAYLOR.
1873.

REPORT OF THE STATE BOARD OF VISITORS.

To the General Assembly of the State of Connecticut:

THE undersigned, on behalf of the Board of Visitors, whose duty is to annually report upon the condition of the Sheffield Scientific School, respectfully state that they have visited the institution twice during the past year.

At the last Commencement twenty-six persons were graduated in the various departments, and in September one hundred and one new students were admitted as members of the School, eighty of whom entered the Freshman Class. The aggregate number of students for the current year is two hundred and one.

The State Scholarships, twenty-seven in number, have been entirely full for several years past, and although all applications for scholarships have been granted up to this time, it is evident that hereafter there will be more applications than vacancies, and that a strict conformance with the law must be observed in the appointments. The act of legislature requires, "in case there are more applications for the bounty of the State than there are vacancies to be filled on the part of the State, said Board shall give the preference to such young men as are fitting themselves for agriculture and mechanical or manufacturing occupations in life, who are or shall become orphans through the death of a parent in the naval or military service of the United States; next to them, such as are most in need of pecuniary assistance; and, furthermore, they shall provide that the appointments shall be distributed, as far as practicable, among the several counties, in proportion to their population."

The new building, the commencement of which was announced in the last report, is now nearly completed, and will be entirely ready for use this summer. It is a very substantial structure,

and is finished and equipped in the most complete manner. The building, with the lot on which it stands, is a gift to the institution from its noble and munificent patron, Mr. JOSEPH E. SHEFFIELD. A detailed description of it will be found in the accompanying report of the Governing Board.

During the last year the School has lost the valuable and valued services of Professor Gilman, who has been called to another field of usefulness. We regret his leaving, but congratulate the State of California on the accession it has received. We are glad to state, however, that the School has been more than fortunate in inducing General Walker, late Commissioner of Indian Affairs, and Superintendent of the United States Census, to accept the vacant chair. In him the institution gains a professor whose past furnishes unmistakable promise for the future, and who will be a worthy successor of the man whose place he takes.

The benefit which the Scientific School has conferred upon the State in turning out young men who, on leaving the institution, are enabled to assume the position of leaders in their several callings, and of educators of the people to a higher grade of culture, increasing the productive brain capacity as well as the material wealth of the country, cannot be estimated in dollars and cents. From all parts of the country come back most favorable reports of the graduates who have been sent out, and their influence, already great, is constantly on the increase. The people of this State cannot do too much for an institution which has already done and is continuing to do so much for them, by developing the material resources of Connecticut, and by extending its reputation throughout the entire country.

In behalf of the Board,

MARSHALL JEWELL, *Chairman.*

BIRDSEY G. NORTHROP,
Secretary of the State Board of Education.

NEW HAVEN, MAY, 1873.

ANNUAL STATEMENT

OF THE

GOVERNING BOARD.

In presenting their Eighth Annual Statement in respect to the progress of the Sheffield Scientific School of Yale College, the Governing Board refer with special pleasure to that manifestation of public confidence in their work which is exhibited by the rapidly increasing number of students in attendance. This number had been steadily growing for several years past, and had at length become so large as to task the somewhat limited resources of the School for their proper accommodation; and accordingly a part of the work has been for some time necessarily done off the ground. In particular, the instruction in Dynamic Engineering had been given in the Art School building, and a great part of the work in Natural History had been carried on in the building originally used for the Trumbull collection of paintings. For the purpose of providing suitable accommodations for these, and of furnishing relief to the other class-rooms already crowded to their utmost capacity, Mr. Joseph E. Sheffield determined to add another to the munificent gifts already made by him, by which the success of this School has been in the past mainly secured. Early in the beginning of last year, therefore, he began entirely at his own motion and expense the construction and equipment of a new edifice, which stands on Prospect street, directly north of the present hall, and which is to be devoted to lecture-rooms, class-rooms, and collections. This building is now at the point of completion, and will be entirely finished before the end of the summer term; indeed, use is already made of a number of the rooms. The gift, it may be added, was as timely as it was munificent; for the increase of the last entering class was so unprecedented, and so entirely beyond the expectations of the Governing Board, that it has severely strained their resources to meet the demand upon them for room. In accordance with the promise made in the last annual report, a detailed account of the new building is here

Description of North Sheffield Hall.

The plan of the building, arrangement of rooms, character of finish, and other general features, were decided on by a committee of the Trustees appointed by Mr. Sheffield, and, with his approval, an architect, Mr. J. C. Cady of New York, was employed to furnish designs for the exterior faces and for the details of the interior work.

Contracts for the execution of the work were then made by Mr. Sheffield with Messrs. Perkins & Chatfield for the masonry, and with Mr. Charles Thompson for the carpenter's work, and the building was begun early in the spring of last year. It occupies a lot on Prospect street about two hundred feet north of Sheffield Hall. The lot has a front of one hundred feet and a depth of one hundred and ten feet.

The new building has a front of seventy-six feet on Prospect street, and a depth of eighty-four feet, standing back from the street sixteen feet.

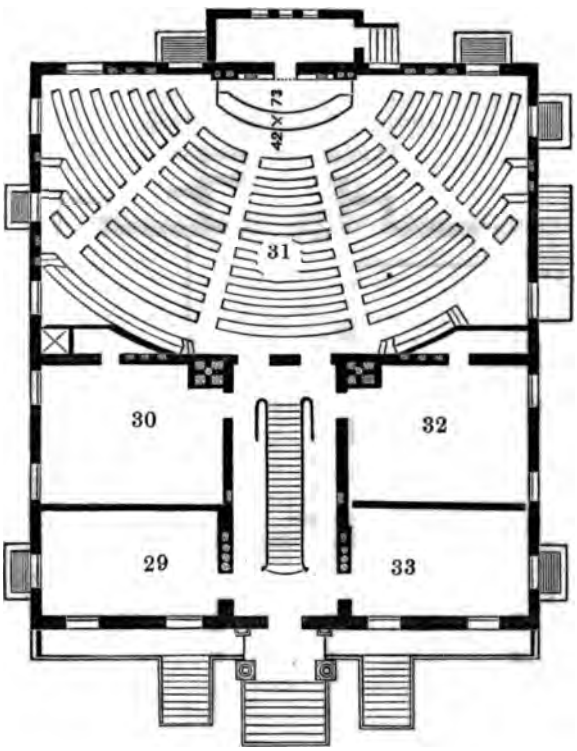
The plan is rectangular, and it has substantially five stories,—a basement of eleven feet in height, first, second and third stories, each fourteen feet high in the clear, and an attic or fourth story nine and a half feet high in the clear. The foundation walls to the water-table are of brown stone in courses, rock-faced. The water-table, window and door sills are of blue stone, and the main walls of red brick; white fire bricks and blue stone bricks being employed in band courses, in the arches of the openings, and in the cornices.

The front porch constitutes the only ornamental work exterior to the main walls. This part of the structure and the chimney caps are built of a light colored Amherst (Ohio) stone.

The general plan of the interior arrangement of rooms is based on that of the first story, provision being made for a large lecture-room in the rear part of this particular one, extending across the whole rear side of the building, and occupying nearly one-half of the story. This lecture-room has a capacity for seating about four hundred and fifty persons. A hall sixteen feet wide from the front entrance communicates with this lecture-room, and affords room for the main staircase to the upper stories. On each side of this hall there are two recitation-rooms, one $12'.5'' \times 27'.5''$ and one $12'.11'' \times 26'.9''$, making four recitation-rooms and a large lecture-room on the first floor.

NORTH SHEFFIELD HALL.

PLAN OF THE MAIN STORY.



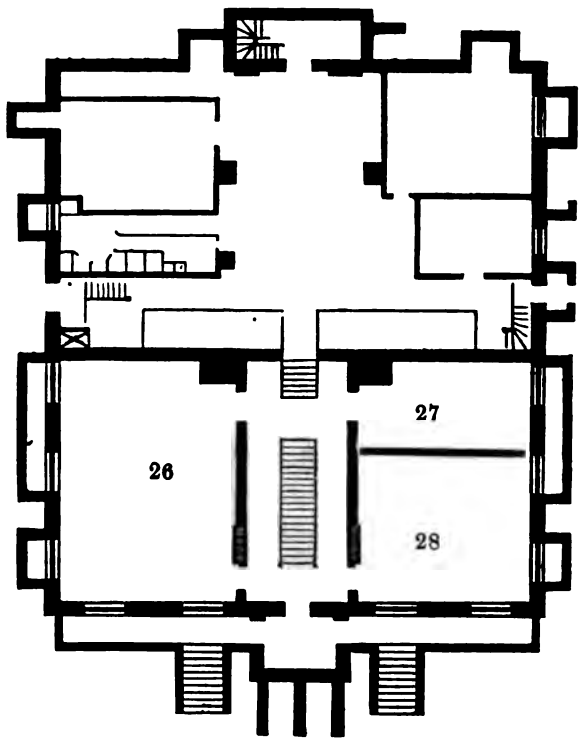
No. 29. Recitation-room.
30. Recitation-room.
31. General Lecture-room.
32. Recitation-room.
33. Recitation-room.

Under these four recitation-rooms in the basement of the building there are two large rooms and one small room completely finished. These rooms are all suitable for recitation-rooms, being well lighted and having a height in the clear of eleven feet.

The rear basement, under the general lecture-room, is occupied by a coal-room, heating furnaces and boilers, janitor's room, and water closets. The floor of this part of the basement is lower than the front part by four feet, to permit the floor of the lecture-room above to drop down from the front toward the speaker's table.

NORTH SHEFFIELD HALL.

PLAN OF THE BASEMENT.



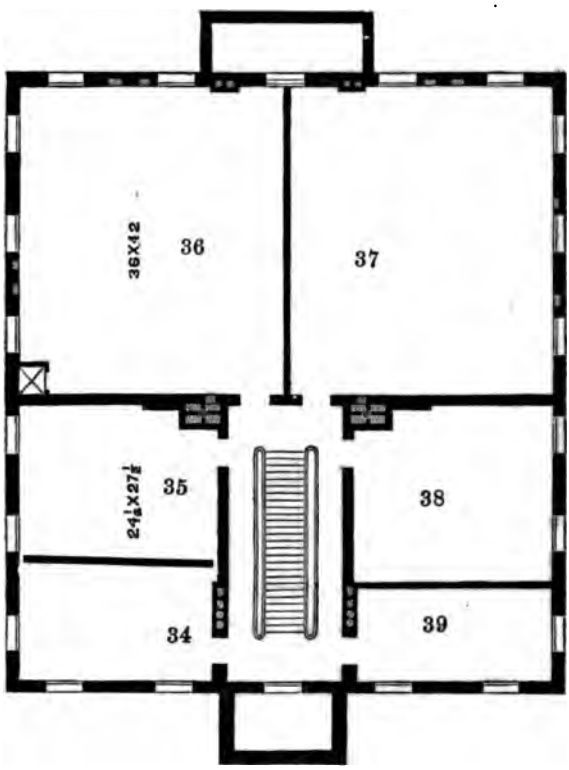
No. 26. Recitation and Lecture-room.
27. Shop for Professor of Physics.
28. Recitation-room.

e second and third stories are divided alike,—two large rooms ual size in each over the lecture-room, and four rooms on each in the front of the building off the main halls.

e south side of the second story, consisting of three rooms, is ed to Physics, the north, consisting of three rooms, to Civil neering. The small rooms in front are, for the present, priated to the Professors in those departments for study- s, the middle rooms for apparatus and recitation-rooms, and ear and largest rooms for apparatus, lectures, and drawing- s.

NORTH SHEFFIELD HALL.

PLAN OF THE SECOND STORY.

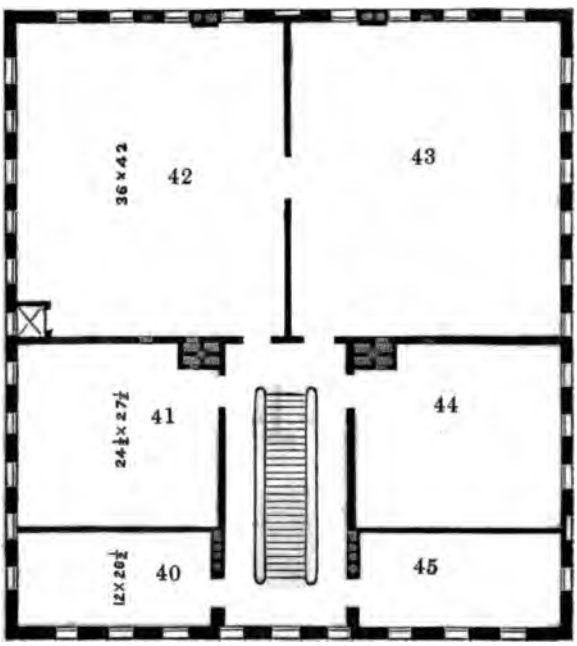


No. 34. Private study, Prof. Norton.
35. Recitation-room, Civil Engineering.
36. Apparatus and Drawing-room, Civil Engineering.
37. Lecture-room, Physics.
38. Apparatus-room, Physics.
39. Private study, Prof. Lyman.

The third floor is arranged in a similar way. The south side devoted to Dynamic Engineering, the large rear room on the no side to Natural History, the middle room to Botany, and the fr to the purposes of a private study.

NORTH SHEFFIELD HALL.

PLAN OF THE THIRD STORY.

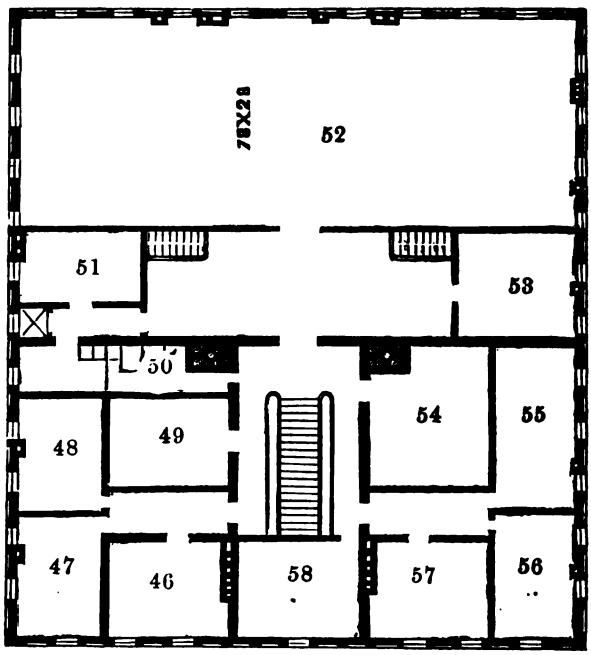


No. 40. Private study, Prof. Walker.
41. Botany, Prof. Eaton.
42. Natural History, Prof. Verrill.
43. Model and Drawing-room, Dynamic Engineering.
44. Recitation-room, Dynamic Engineering.
45. Private study, Prof. Trowbridge.

ıe fourth story furnishes one large room (73′×28′) for instruc- in instrumental drawing, and eleven small rooms to be occu- as private rooms for instructors, and for store-rooms.

NORTH SHEFFIELD HALL.

PLAN OF THE FOURTH STORY.



No. 46. Private room for instructors.
47. Do. Do.
48. Do. Do.
49. Store-room.
50. Water closets.
51. Private room for instructors.
52. Drawing-room for Freshmen.
53. Private room.
54. Store-room.
55. Private room for instructors.
56. Do. Do.
57. Do. Do.
58. Do. Do

The interior finish of the building is plainly executed in yellow pine, coated with oil and shellac. The staircase and wainscoting of the halls are composed of pine, ash, and black walnut.

The building is heated and ventilated by the process and apparatus of Messrs. H. B. Smith & Co. of Westfield, Mass.

The boilers in the basement furnish steam which passes through pipes to steam chambers or "radiators" under the rooms to be heated; a current of cold air passing through conduits to the radiators is heated in its passage upward to the rooms by the steam-heated "radiators." To furnish places of exit for the heated air separate air conduits from all the rooms, provided with ventilators, pass up through the walls to the roof.

The larger lecture-room and all the recitation-rooms except two have ventilators opening into large conduits in the center of the building, which are kept heated by the smoke flues of the boilers, which are of cast-iron and pass up through the middle of these large conduits or ventilating shafts.

The building is thus not only thoroughly warmed but most efficiently ventilated. A trial of one winter of the apparatus of Smith & Co., arranged by their agent, Mr. Brownell, has fully confirmed the anticipations of the Trustees as to the efficacy of this mode of heating and ventilation.

As regards the carpentry and the mason work, the Trustees who have superintended the building operations not only wish to express their unqualified satisfaction with the manner in which it has been performed, but they feel that it is no more than simple justice to the respective contractors, Mr. Charles Thompson and Messrs. Perkins & Chatfield, as well as to H. B. Smith & Co., that public witness be borne to the integrity and ability with which they have carried out in every particular their contract. The plumbing work executed by Williams & Howland, and the gas work executed by Mr. Stratton of Derby, also give thorough satisfaction.

Before concluding, the Trustees likewise desire to say that too much praise cannot be awarded to the architect, Mr. J. C. Cady, of New York City, for the skill and success with which he has triumphed over difficulties of no ordinary character, in giving to the building an imposing architectural effect, without sacrificing in any way the convenience of the interior arrangement.

Resignation of Professor Gilman.

The Governing Board regret to be under the necessity of chronicling the loss of one of their number, Professor Daniel C. Gilman, who has given up his position in this institution to accept the presidency of the State University of California. Professor Gilman was at a very early period interested in the Scientific School, and labored assiduously both in public and private to extend a knowledge of its operations and to promote its success. In 1862, while still holding the office of Librarian of Yale College, he first became connected with it as an instructor, and at the Commencement of 1863 was elected Professor of Physical Geography. Resigning in July, 1865, the office of Librarian, he from that time devoted his time and energies to the success of this department of Yale College, and was the principal exponent to the public of its work and progress. Yielding to repeated solicitations he accepted last year the presidency of the University of California, and departed to that State in October; and there his zeal, his ability, his untiring energy, and his fertility of resources have already begun to make themselves largely felt. None parted from him with more regret than those who had so long been associated with him in the management of the Scientific School; and they desire to express publicly here their appreciation of his earnest and constant efforts to promote the growth of this department, and their full confidence in and hope for his success in the new and broad field of labor upon which he has entered.

Addition to the Corps of Instructors.

The rapid growth in numbers of the School had been for some time forcing upon the attention of the Governing Board the necessity of increasing the teaching force in branches already embraced in the curriculum, and of providing instruction in some which had hitherto received little or no attention. The departure of Professor Gilman seemed, therefore, a suitable time to remodel to some extent the course of study, and to make some needed additions. Accordingly the instruction in Physical Geography was confided to Professor Brewer, it being a subject to which he had for a long time given special attention; and the chair of Political Economy and History was founded, to fill which an invitation was extended to General Francis A. Walker, then Commissioner of Indian Affairs. This action of the Governing Board was confirmed by the Corporation of Yale College at its meeting of December, 1872;

the offer was accepted, and at the beginning of the second term General Walker entered upon the discharge of his duties. Professor Walker was graduated at Amherst College in 1860, and after a short time spent in the study of law, entered the army at the breaking out of the civil war in 1861. In this he remained until its close, occupying nearly all the time the position of Assistant Adjutant-General, and rising successively through the grades of Captain, Major and Lieutenant-Colonel, with brevet rank as Colonel and Brigadier-General for distinguished services. After the disbanding of the army he was engaged from 1865 to 1868 in teaching at Amherst College and at Williston Seminary, Easthampton, and in the last-named year became connected with the editorial staff of the Springfield *Republican*. In June, 1869, he was made deputy special commissioner of the revenue, having in charge the bureau of statistics, and in February, 1870, was appointed superintendent of the census. In this position he organized and conducted the ninth census of the United States. In November, 1871, he became Commissioner of Indian Affairs, and at the close of the last year resigned that position for the purpose of accepting the above-named professorship in the Scientific School.

Previous to this time the necessity of increasing the teaching force in the modern languages had become imperative; and during the middle of the last academic year the Governing Board were fortunate enough to secure the services of Professor Albert S. Wheeler, who assumed part of the instruction in the German language. With the beginning of this year the whole instruction in that department was placed in his charge. Mr. Wheeler had had much experience in teaching, having previously held the professorship of Greek in Hobart College, Geneva, N. Y., and of Latin and Greek in Cornell University. During the present year an additional instructor in French, Mr. Jules Luquiens, has likewise been added.

In pure Mathematics provision has also been made for a more thorough and extensive course by placing this department in charge of Mr. John E. Clark, who has successively held the Professorship of Mathematics in Michigan University, and in Antioch College, Ohio, but who at the time of his accepting the position was engaged in the survey by the United States Government of the North-western Boundary.

Extension of the Course of Study.

At the request of the Governing Board, the Corporation of Yale ollege, at their meeting of March, 1873, created the degree of ynamic Engineer, to be given to students who had successfully ırsued the course of study of dynamic engineering for two years ter their graduation as bachelors of philosophy. To correspond ith this, the course of graduate study for the degree of Civil ngineer was extended from one to two years.

This extension had been for some time contemplated, as has also ɔen the extension of the course of undergraduate study from three four years. This last is a measure for which there is a great ɔcessity, as some subjects of importance are, in the present limited me, unavoidably hurried over, or not studied at all. But the ɪtension of the course to four years involves so large an outlay the procurement of additional instructors and further accommoɪtions, that the Governing Board have not yet felt warranted in ɔmmitting themselves decisively to any definite action. It is ɔmewhat disagreeable to be under the necessity of reminding the iends of the institution that the increasing number of students, hile it is a source of great gratification and encouragement, is so attended with some disadvantages. The increase in the ıcome caused by the admission of a larger number of students ill never be sufficient to balance the expense of employing addiɔnal teachers for the purpose of furnishing them proper instrucɔn. The best results of education can never be obtained where ıe divisions into which classes are arranged are large and cumɔrsome; and small divisions can only be secured by a corresɔnding increase in the teaching force. No institution, aiming to ɔep up the highest standard of instruction, can ever be self-supɔrting; and it is a fact somewhat unpleasant to contemplate, that ıe growth in numbers of a school, ordinarily the most conspicuous gn of its prosperity, must necessarily always have the tendency) cause some deterioration in the character of the instruction, nless assistance is obtained from sources outside of the income ɔceived from the students themselves.

National Aid to Schools of Science and Technology.

In the last annual report reference was made to the Congressɔnal land grant of 1862, to the great benefits, outside of the direct ecuniary endowment, which this institution in common with many thers had received from it, and to the possibility of an additional

grant to the several institutions aided by the original act, a bill having then been introduced in the Senate with that object in view. Believing, as we do most firmly, that no small share of the proceeds of the public lands should be devoted to the purposes of higher education, we expressed then and there our confidence in the wisdom of the original enactment, and in spite of occasional failures, of its great benefit to the country generally, and especially called attention to the fact that it secured local responsibility under national aid; scientific education without any disparagement of literary culture; scientific schools rather than simple agricultural schools; and instruction funds instead of brick and mortar. During the last session of Congress, two different bills, making additional grants, passed the Senate and the House of Representatives by overwhelming majorities in each; but in the hurry which necessarily attends the closing hours of Congress, the measure failed for lack of agreement between the two houses as to details.

Lectures to Mechanics.

The annual course of lectures to mechanics, which have now for seven years been uninterruptedly given, was this year necessarily discontinued on account of the lack of room. The large hall of the Scientific School was, in consequence of the increased size of the classes, occupied during the winter term four hours every day, and no time could be found to make preparations in it for evening lectures. The hall in the new building will in the future obviate any such difficulty.

Additions to the Zoological Collections.

A. E. VERRILL, CURATOR; S. I. SMITH, ASSISTANT.

During the past year the principal part of the special work in Zoölogy has been devoted to the marine animals of New England and adjacent waters. In this department our collection is now far in advance of that in any other museum. Most of this work during this, as well as last year, has been done in connection with the investigation of the fisheries, by Prof. S. F. Baird, U. S. Commissioner of Fish and Fisheries. During the summer vacation the Curator, with a party, including Mr. S. I. Smith, Mr. O. Harger, Mr. T. H. Prudden, and Mr. G. W. Hawes, assistants in this School; Prof. J. E. Todd, of Tabor, Iowa; Mr. J. B. Isham, and Mr. J. K. Thacher, of New Haven; Mr. J. H. Emerton, of Salem, Mass., and several others, joined Prof. Baird and his party at Eastport, Me.,

and took charge of the investigations concerning the Invertebrate Animals of the Bay of Fundy, and made a very large and valuable collection. Of these a full series is to be permanently retained in our museum, while the duplicates are to be distributed to other institutions, after being carefully identified. Later in the season Messrs. Smith and Harger went to St. George's Banks on the U. S. Coast Survey Steamer Bache, and carried on dredging operations in that region. During this trip they dredged successfully at various depths down to 430 fathoms, which is the deepest dredging hitherto made on our coast, north of Florida. They succeeded in making a valuable collection, although the time available for dredging was short and the weather quite unfavorable. Later, Dr. A. S. Packard and Mr. Caleb Cooke, of Salem, Mass., made another trip on the same steamer and obtained many valuable additions to the Fauna of that region.

All these collections are at present in our laboratories, and have, as yet, been but partially studied. The general results of these explorations, together with descriptions of some of the new species, have been published, in part, by the Curator in the *American Journal of Science*. The results of the explorations of the St. George's Banks have been given in detail by Mr. S. I. Smith and Mr. Oscar Harger in a paper prepared for the *Transactions of the Connecticut Academy*.

The work upon the collections made in previous years on the southern coast of New England and the preparation of a report upon them have occupied much of the time both of the Curator and of Mr. S. I. Smith. Mr. Harger has also aided in this by elaborating the Isopods.

The detailed and illustrated report upon the marine Invertebrates of southern New England, for the U. S. Fish Commission, is now in press.

The osteological collection has also been greatly enriched during the past year, mainly through the very liberal donations made by Professor Marsh, who has not only purchased a large number of rare and valuable specimens, both mounted and unmounted, but has employed men to prepare a large number of skeletons from fresh specimens. Among the skeletons of special interest given by Professor Marsh is that of the East Indian two-horned black rhinoceros, accompanied by the mounted skin; the wombat; an ant-eater; the mountain tapir of South America, and the Mexican tapir.

Many valuable osteological specimens have also been presented by Mr. *G. B. Grinnell (Yale*, 1870), of New York.

Rev. T. C. Trowbridge has forwarded the skeleton and skin of a camel from Turkey, together with other valuable specimens.

Mr. W. C. Coup presented an alligator, a boa, and the skeleton of a young African elephant, eight months old, of which the mounted skin was afterward obtained by purchase.

From Professor Baird we have received a collection of skins of sharks and rays taken in Vineyard Sound in 1871.

It is with great regret that we record the death of Capt. M. S. Porter, of New Britain, who was an excellent friend of our School, and who took great interest and pride in adding to our collections, whenever he had opportunities. He died very suddenly in Australia, last spring. From his father we have received a very beautiful and valuable collection of Australian birds, an ornithorhynchus, etc., which Capt. Porter had secured for our museum just before his death.

Capt. J. M. Dow presented an interesting collection of fishes, reptiles, crustacea, etc., from Central America.

From the Smithsonian Institution we have received a collection of seventeen bird-skeletons, collected in Alaska by Mr. H. W. Elliott, and a series of typical specimens of Muridæ, identified by Dr. Elliott Coues.

Numerous other donations have been received, which will be acknowledged elsewhere.

Additions to the Geological Collections.

O. C. MARSH, CURATOR.

Very considerable additions to the Geological Department of the Museum have been made during the past year, and a large proportion of these additions have been remains of fossil vertebrates, to which particular attention has been directed throughout. Unfortunately, for want of room, most of the recent acquisitions cannot be exhibited at present. In arranging and investigating the large acquisitions received by the Museum, valuable assistance has been rendered by Mr. Harger, Assistant in Palæontology.

Continued efforts have also been made by this department during the year to increase the collection in Osteology, more especially as an aid to the study of vertebrate remains. Several hundred skeletons of recent animals, most of them carefully identified, have been obtained during the year, so that ample facilities are now afforded for the study of Comparative Osteology. In increasing the collections in this department, important aid has been given by Mr. G. B. Grinnell, of the Class of 1870.

The most important and valuable additions to the Geological collection during the past year have been obtained from the Cretaceous deposits of the West. A very valuable portion of them was obtained by a small party, which left New Haven, in October last, under the charge of the Curator, and spent about two months in Kansas, Colorado, and Wyoming, collecting fossil vertebrates.

Among the specimens from this region may be mentioned, perhaps the most interesting fossils yet obtained on this continent, the *Ichthyornidæ*, or the remarkable extinct birds with *teeth* and *biconcave vertebræ*, from the Cretaceous deposits of Western Kansas, a region already well known as abounding in fossil reptiles and fishes. Additional and very perfect remains of the large diving bird of the Cretaceous period (*Hesperornis regalis* Marsh) were obtained by the Yale party last autumn.

From the Tertiary deposits of Wyoming, many interesting fossils have been obtained, and among them are several specimens of the remarkable new group of mammals which have been named *Dinocerata* by the Curator. A description of these specimens, with figures of the most perfect skull, has been published in the *American Journal of Science* and in the *American Naturalist*. In the former Journal more than fifty new species of extinct American mammals, besides many reptiles and birds, have been described during the year by the Curator. The types of these species are now in the Museum, and naturalists will fully appreciate the increased value which has thus been conferred upon the specimens, many of which are unique.

A very considerable and expensive collection, mostly of foreign vertebrate fossils, has been obtained from Europe, and a large collection of bones of extinct birds from New Zealand. Other important additions have been received, which will be fully acknowledged elsewhere.

Additions to the Museum of Archæology.

The acquisitions in this department have been large and important during the past year, although no opportunity is yet afforded for making them available for study. The most valuable addition has been a large collection of Antiquities, mostly from Central America, which was made by M. de Zeltner, Consul of France, during his long residence at Panama. This collection contains probably the finest series of gold images and pottery from Chiriqui ever brought together, and is also especially rich in stone imple-

ments. The entire collection was purchased in Paris by Professor Marsh, and presented to this department.

Another collection of much interest is a large series of native skulls from the Sandwich Islands, presented by Hon. J. S. Christie, Jr., vice-consul of the United States at Honolulu.

Large collections of stone implements, especially from the West, have also been received, and many other acquisitions of importance, which will be duly acknowledged in the list of donations.

Specimens intended for this department may be sent to Prof. O. C. Marsh.

Additions to the Mineralogical Collection.

G. J. BRUSH, CURATOR.

The duplicates of the collection of minerals have during the year been arranged by Mr. L. Stadtmueller, and many new specimens have been added to the general collection.

The most valuable acquisition made during the past year is a diamond crystal imbedded in its native rock from South Africa. This grand specimen is estimated to weigh sixteen carats, and was presented to the Scientific School by Chas. M. Wolcott, Esq., of Fishkill, New York.

Gifts to the Institution.

In addition to the sums subscribed for income mentioned in the last annual report, the School has received $1,000 for the general fund from Mr. John J. Crook of New York City.

A gift of $570 has also been received from the Class of 1871, through Mr. H. B. Sargent, the Class Treasurer.

Proposed Professors' Fund.

It has been previously announced that a friend of the School had offered to it $10,000, on condition that $50,000 be raised before the Commencement of 1873. Of this amount $26,000 have been subscribed, and $6,000 paid in. This leaves $24,000 still unprovided for.

The Library.

During the past year a number of accessions have been made to the Library, partly by gift and partly by purchase. Among the former are to be mentioned copies of Webster's and Worcester's Dictionaries, presented by their respective publishers; numerous publications of the Engineering Department of the United States

Army; a complete set of the Patent Office Reports, section of Mechanics, by Professor Walker; and an elegantly illustrated Catalogue of the plated goods manufactured by Rogers, Smith & Co. To these and numerous smaller donations are to be added a collection of valuable scientific works and periodicals previously presented by the heirs of the late N. A. Bacon, Esq., but accidentally unacknowledged in the last Report. The additions by purchase have been few, the fund being in great measure exhausted by subscription to the current scientific periodicals, and by the necessity of putting the Library in thorough order. This latter has been going on steadily during the past year, a large number of volumes having been bound, and the work of making out a card catalogue having been undertaken.

Latin Entrance Examination.

No sooner had regular courses of study been organized in this institution than the deficiency of many students, otherwise well prepared, in a knowledge of common principles of grammar became painfully apparent. In consequence of this the teaching of German, of French, and of English was attended with special difficulties, and much delay was caused and the time of the better prepared scholars wasted by the constant necessity of instructing the less advanced students in the most elementary conceptions of grammatical analysis, and even of the meaning of the most elementary terms in grammatical nomenclature. As the classes increased in size this evil became a still greater source of trouble, and with the view of remedying it, the Governing Board, after full consideration, announced in the annual report for 1867–68 that after a certain period, as a condition precedent to entrance, a knowledge of Latin would be required sufficient to read and construe some classical author. No particular amount has ever been required in practice, it not being the intention to make the examination for the first few years at all rigorous. But even the result of this trial has fully satisfied the Governing Board of the wisdom of their course, and it is now believed by them that the time of experiment has fully passed. In the meanwhile, many letters have been received from all parts of the country in regard to the subject: some from applicants for admission wishing to be excused from this particular study, or desiring specific information as to the best manner of preparation and the length of time required; others from teachers asking for more precise and definite statements in regard to the nature and extent of the examination.

With the idea of giving the fullest information to the public on all the points which had thus been brought before them, a series of questions, at the entrance of the last class, was addressed to each individual student as to the length of time he had spent in the preparation of Latin, and the extent of his reading, and a careful record was made of the proficiency of each applicant for admission, both as regards his knowledge of grammar and his facility in translating, with the idea of comparing it with his progress in the linguistic studies of the course. With this basis of facts collected the Governing Board, at the beginning of the academic year, appointed three of the instructors, Messrs. Wheeler, Whitney, and Lounsbury, a committee to report on the whole subject of Latin, so far as regards its connection with the education given in the Scientific School, and especially to take into consideration the various questions which had been raised by the inquiries of instructors and students. The report of the Committee was presented, through its chairman, Professor A. S. Wheeler, on Feb. 19, 1873, and after full discussion was adopted, as expressing the mature views of the Governing Board, and ordered to be printed in the annual report of the present year. The personal details upon which the conclusions are founded are, for obvious reasons, omitted; but the general conclusions which were drawn from an analysis of the facts presented are given in the following report.

Report of the Committee on the Latin Entrance Examination.

To the Governing Board of the Sheffield Scientific School,—

The Committee on the Latin Entrance Examination respectfully report:

In the absence of specific instructions the Committee have felt some perplexity in determining the precise range of topics which the report should cover, and have, therefore, felt obliged to follow their own judgments in regard to the fullness of treatment which should be given to various matters which have been brought to their notice. To those, consequently, who are unacquainted with the special circumstances that have taken place or the special inquiries that have been made, much included in the report may seem irrelevant or stated with too much detail.

The general plan of the report may be stated as follows:—The facts of the last entrance examination are first analyzed, compared, and commented upon, and the relation existing between them and

the subsequent linguistic studies brought clearly into view; and in the second place, some suggestions, to which the consideration of the examination naturally leads, are then offered in regard to the proper quantity and kind of Latin reading, to methods of study, and to text-books. In this latter special efforts have been put forth to make as full and as satisfactory replies possible to the numerous inquiries on the topics under discussion which have been addressed to the Governing Board, both by instructors in the preparatory schools, and by students asking information for guidance in their studies.

(Here follows an extended statement of facts connected with the last Latin entrance examination. As it consists mainly of personal details, it is necessarily omitted.)

It is seen from the foregoing that among those who were regarded as well prepared, there were two marked and quite different kinds of preparation exhibited at the examination. These may profitably receive fuller and more careful consideration. They are representative of what, with some variation in degree and extent, may be expected in any similar examination, unless the requirements pronounce categorically in favor of one of them.

There is, first, what may properly be called a *grammatical* preparation, where there has been a small—perhaps very small—amount of Latin reading, but where the leading principles and terms of grammar have received careful attention, and where each sentence, or each word even, of the Latin read has been used for grammatical praxis, until by systematic reviewing the vocabulary and the most essential grammatical rules have been quite thoroughly mastered. It is not supposed that this study of the Latin Grammar is carried beyond what is necessary for the ready analysis of forms, and for the mastery of the leading rules of syntax. The grammar is studied as a preparation for intelligent reading, though but a small amount of reading is actually accomplished, and is not studied, as is sometimes the case, as though reading were done merely for the purpose of illustrating a grammar, and as though no useful reading were possible until every rule and every subdivision of it should have been memorized and repeatedly applied in parsing.

The second kind of preparation, for which it may be difficult to find an entirely suitable name, but which perhaps may suitably enough for present purposes be called *literary* preparation, differs from the former chiefly in extent of reading, and consequently in the acquisition of a far more extensive Latin vocabulary. It will

be true no doubt that this further reading will tend to give a more absolute command over the grammatical forms and principles already studied than was possible to get from the reading of merely a few dozen pages of Latin authors, but it is assumed that the formal study of new topics in the grammar need not be carried to any great extent. Important deviations from rules already learned will of course be noted and remembered, and references to the grammar will be habitually made, but the chief reliance for advance in grammatical knowledge will be placed upon the student's own observation and induction; while the mastery of words and the study of the author's meaning will be held up as the great objects to which all others are to be subordinated. The student who has acquired this latter sort of preparation to the extent assumed by the report will be able to command a vocabulary of several thousand words, and be in a position either to prosecute Latin studies further with ease and advantage, or to take up other studies, for which a respectable amount of Latin is a valuable if not an indispensable preparation.

Of course, when these two kinds of preparation are contrasted, no one would hesitate in deciding which should be preferred. It is substantially a choice between more and less. Some would even maintain that the value of the knowledge gained in the former case would not repay for the time and labor consumed; that the study should either be carried further, or neglected altogether. But on the other hand, when one considers the deficiencies of the English grammars, and indeed the difficulty in making English the subject of grammatical analysis for those who use it as their mother tongue, unless the student is already trained in language; when one remembers the great excellence, for most purposes, of the Latin grammars, and of the whole body of classical text-book literature—the work of many generations of great scholars—as compared with the corresponding books that have as yet been prepared as hand-books for the study of any of the modern languages; that, surely, should not be regarded as useless knowledge, or as wasted labor, which does no more even than to give clear views of the elements of grammar and thus to make the study of English or of a foreign modern language easier and pleasanter than it could otherwise have been made. The very great value of this elementary knowledge of Latin, as a preparation for the course of study at the Scientific School, has been clearly illustrated during the present year. In but very few cases has a student, who was conditioned in Latin, done well in German. On the contrary, those

who have experienced marked difficulty in learning accurately and satisfactorily what was required in German have in most cases been those who were unprepared in Latin. Facts and principles, which the other members of the class apprehended and learned with ease, have been to these a constant source of difficulty and perplexity. Not only have common rules and terms been habitually misapprehended, such as the agreement between an adjective and its noun, the difference between the dative and accusative cases, between the remote object and the direct object, but even the parts of speech and the simplest case-relations, things capable of being perfectly learned from the proper study of any tolerable English grammar, have been very frequently confounded. The term examinations in the modern languages gave a result in harmony with what has been stated of the recitations. It ought also to be added that the carefully proved facts of this year, both as regards recitations and examinations, do no more than confirm the impressions on these very points made upon the instructors in the modern languages during previous years.

In view of the facts thus presented the Committee have no hesitation in saying that the wisdom of the action of the Scientific School in requiring knowledge of Latin as a requisite for admission has been fully justified; that the students who come ill-prepared in Latin, unless of exceptional mental abilities, are placed at a great disadvantage in the study of modern languages as compared with those who have received a respectable training in that tongue; and that so far from lowering the standard of admission in this respect it should in time be made much higher, and a conformity to the present requirements should be rigidly enforced.

If the Latin preparation, even when only a minimum standard be enforced, be so manifestly and so immediately useful in pursuing the German course, where the historical connection between German and Latin is so slight and remote, it could hardly fail to tell with increased importance upon a course of French study. Here, indeed, a preparation in Latin would seem quite indispensable, especially if there were any attempt to pursue the study of French historically, and to read the earlier French authors.

It may be said, further, in showing something of the utility of the short but definite and thorough course which the so-called grammatical preparation requires, that this is amply sufficient to enable a scientific student to master readily the derivation and signification of all scientific terms of Latin origin, to read, with the aid of a dictionary, such scientific Latin as he should wish, and

to study, with ease, any of those languages which, like the French, are descended from the ancient Latin. Much that might be added in this place is omitted, as it seems to be rather a discussion of the general utility of Latin, which the Scientific School has by its requirements assumed. All that is designed here is to show the unmistakable value of even the limited but definite Latin preparation, which has been described above, in case the requirement of a higher standard of preparation should be thought unadvisable. It may be stated here, as it was not expressly stated above, that this so-called grammatical preparation is not and cannot be attained by mere study of grammar, nor should he be regarded as having attained it, who has not taken the trouble to remember his vocabulary such as it is, no matter what skill he might show in the manipulation of it. Young students are apt to fancy that the knowledge of a grammar and the knowledge of a language are identical, and frequently do not conceive of the practicability of acquiring such a vocabulary as to render a dictionary in a measure unnecessary, or to reduce to the minimum the necessity of referring to it.

The Committee have given some reflection and made some inquiry from experienced teachers upon the question how much time is required for such preparation as the examination disclosed, as well as for such preparation as the report has considered. It seems to be clear that in one year of efficient instruction and of reasonably diligent study a student should acquire an adequate amount of grammatical knowledge and read carefully at the very least three books of Cæsar, or something else equivalent to it, while if the student be not quite young, there is no reason why from four to six books may not be accomplished. At any rate it may be regarded as settled that to secure the first kind of preparation recognized above, and to read besides—not to name a definite amount—considerably more than is there assumed as necessary may easily be done in one year, unless there is some great inefficiency in the instruction, or some absurd method followed, or an uncommon want of diligence or capacity on the part of the student.

It is more difficult to say how much time is necessary to attain the second standard of preparation that has been mentioned, inasmuch as the amount and kind of reading may vary materially; but there can be little risk in the statement that after the first year's study, which would involve the reading of from three to six *books* of Cæsar, or what is equivalent to it, a student should read

in the next year or eighteen months what would constitute very liberal preparation.

It will be seen that the opinions herein expressed as to the time necessary for certain reading are not fully supported by the statistics of the examination. These statistics do, indeed, show that the lower kind of preparation we have described should not consume more than a year at the utmost, and that several of the students who had come up to this standard had studied, apparently without any pressure, not more than a year and in some instances less.

Which kind of preparation should be exacted from applicants for admission to the Scientific School is a question which is probably not included in the subjects referred to the Committee, and the report will therefore go no further than to point out the two above-described kinds of Latin preparation, and the time necessary for each. It may be well to add that the preparation necessary for admission to the Academic Department corresponds pretty closely with the second kind of preparation contemplated above. Though it is believed that a course of reading might easily be selected far better adapted to the future needs of the scientific student than the course usually required for admission to classical colleges, yet, at present, there would be such difficulties encountered in respect to text-books and instruction as renders the recommendation of such a special course unadvisable. Most of the Latin teaching in schools is arranged with reference to the needs of those who are preparing for a course of classical study. Although the authors read, the mode of reading them, and many other things could advantageously be changed in the case of those intending to pursue scientific studies, and who are not aiming at a knowledge of Roman history, literature and antiquities, yet it is doubtful whether a plan better upon the whole could at present be adopted, than, if the standard of preparation in Latin is to be materially raised, to require from all applicants nearly the same Latin preparation as is necessary for admission to the Academic Department. By substituting some equivalents in the reading required, yet not sufficient to interfere materially with the curriculum of the schools, some work could be escaped which for the scientific student would be either wholly useless, or not worth the time it would require.

It is perhaps best to add one statement, however, for the benefit of those who are preparing students for entrance to this institution, and who have asked that more definite information should be given *of the precise nature of* the requirements here demanded.

The Sheffield Scientific School in requiring Latin had a purpose of its own, and one entirely distinct from that aimed at in classical colleges. It was not that its students should be acquainted with the language and literature of that tongue, but that they should come prepared with a knowledge of those general principles of grammar, which are as essential to the proper study and thorough comprehension of German, French or English as of Latin, and which can be best learned through the medium of the last-named language. Anything which does not lead to that result, however good it may be in itself, is not essential to the end had in view. Hence Latin prosody, or Roman history and antiquities, beyond what is necessary to a comprehension of the author read, would necessarily form here no part of an examination. But the general statement being given that Latin is required for the knowledge it furnishes of the common facts and general principles of grammar, it is felt that all application of it may be safely left to the good sense of instructors themselves.

It may be well to consider briefly the subject of the kind of reading most useful for those who aim merely at some knowledge of the Latin language, separated so far as may be from all that is local and historical. Some ancient authors are much farther removed from us than others. Their works are filled with words and phrases, to understand which an industrious collateral study of history, archæology, mythology and similar subjects is indispensable. Others seem almost like moderns, and though they use the Latin language, they express thoughts or describe events or things that are intelligible at once—almost as much so as much of the modern Latin, which has often been the medium of communication between modern scholars. One ought in the study of Latin, as of other languages, to select his reading with reference to the vocabulary that he wishes to acquire, and it is assumed that the scientific student does not wish to spend much time in the study of words representing notions or institutions purely historical. For example, how easy it is to learn that *equus* means horse, and that *aurum* means gold, and how hard it is, and for the general student how unnecessary, to learn what is meant by *judex*, *comitia*, and thousands of other words, that suggest historical facts or local institutions, for which modern life and society have no exact counterpart. Hence, poets who constantly use either rare words or common words in peculiar metaphorical senses, or historians and orators whose sub ect-matter usually necessitates the study of historical events, political institutions, legal processes and defini-

ions, and many other matters purely Roman, would manifestly not be so suitable reading as authors who use largely common words representing conceptions which form the basis of all cultivated languages, and who use them in their radical significations. If, then, a student is aiming not at a general and comprehensive Latin scholarship, his reading should take such a direction as his special objects make most expedient. The student of Roman law would adopt one course; the student of medicine quite another. This remark does not apply to the very early stages of Latin study, as there is a body of common words and phrases and of grammatical usages which are needful for reading anything: only in acquiring these, such authors should be read as present them freest from union with anything non-essential. Hence, Cæsar is, on the whole, a better introductory author than Virgil or Cicero. His vocabulary is simpler and of more general applicability. Many of his words are the names of material things or of simple and easily intelligible notions, and are hence far easier to acquire than words which have been subjected to a variety of metaphorical and rhetorical changes; the nature of his subject makes abstract discussion and therefore the abstract significations of words, and the more difficult grammatical constructions, somewhat though by no means wholly unnecessary, while the style of the author is such as usually to present a difficulty in the most intelligible form possible. Still, Cæsar presents some unquestionable and special difficulties; while the Commentaries, regarded as a whole, do not contain such a variety of words and usages as might easily be found in the same quantity of Latin. Indeed, if the speeches which are interspersed throughout his narrative be considered, or if the work be made, as some teachers make it, the means of teaching what they know—or think they know—of the subjunctive mode, or the whole doctrine of the Oratio Obliqua, Cæsar will be found to present many difficulties that would seldom be encountered in either Virgil or Cicero. These difficulties would be considerably increased if the book were read, as is advantageously enough done by the advanced or the special student, with minute attention to military operations and to the geography and ethnography of ancient Gaul. Still, these possible difficulties may be fairly passed over by the young student, and his attention may be directed to such subjects as Cæsar's narrative style is admirably adapted to teach. If these other matters should become necessary to be attended to, the book may be re-read, with this object, at a later stage *of Latin study.*

But the Committee would not be understood as recommending that an acquaintance with any particular author shall be insisted upon as a condition precedent to entrance; any equivalent amount of any classical writer should, in their opinion, be always accepted as a substitute. For the benefit of those more especially who are carrying on their preparation in this study by themselves, they may be pardoned for suggesting Allen's Latin Reader as furnishing possibly a more desirable course of reading than Cæsar's Commentaries. Embracing a wide variety of selections from classic writers, and containing a large vocabulary, this work is excellently adapted for the use of those who wish a general acquaintance with Latin, but have not the time nor the inclination to pursue the subject far enough to read entire authors. Such a book, thoroughly mastered by repeated readings, would secure a very respectable knowledge of Latin, and one far more useful than is often acquired by a more showy and pretentious course of study. The work has also the additional advantage of being one of a series of Latin text-books, which refer to and illustrate each other. Of one of these,—Allen & Greenough's Latin Grammar,—both on account of its comparative brevity, and from the fact of its embodying some of the most important recent results of the science of language, the Committee feel no hesitation in recommending the use to students in preparing for the Scientific School. This book, indeed, aims to do for Latin scholarship what was so admirably done for Greek by the grammar of Professor Hadley. There are in the possession of the public many valuable Latin grammars, some of which, to be sure, are more particularly designed for advanced students; and it may seem invidious, in consequence, to recommend one book or one set of books in preference to others. Still if one work is, on the whole, superior to others for our specific purposes, and especially if it represents an advancing movement of scholarship and science, it seems advisable to declare distinctly in its favor.

In every branch of classical study there still linger on the stage many old-fashioned and worse than useless books, whose occupation has long been gone, but of which owners of copyrights and publishers are interested in securing the sale. In some localities, Bullions' Greek Grammar is actually preferred to the Grammar of Professor Hadley. And when one really considers the question, is there anything more invidious in the preference of one or of a set of preparatory text-books, than in the choice of one or of a set of books in the collegiate course? Indeed, the injury done in

schools by inferior text-books is greater by far than is possible in the more advanced institutions, as in the latter case the teacher will usually be able to correct the grosser errors of the text-book, and to neutralize, by his own supplementary instruction, its defects and its errors.

A well-made exercise book for practice in the translation of simple sentences from English into Latin, to illustrate the grammar, is one of the Latin series referred to, and the Committee would recommend, in case the suggestion in regard to Latin Grammars be accepted, that this book or a similar one be required also. An acquaintance with it is a guaranty of mastery of forms and rules such as mere translation of Latin into English does not furnish, while the study of it makes such translation easier and more interesting.

There is less objection, in the opinion of the Committee, to the specific recommendation of books and of methods of study, as so much of the Latin teaching in schools is done by comparatively untrained linguists and inexperienced teachers. In the large majority of cases it is believed these are young graduates of college, who for ulterior objects spend two, three, and four years in teaching, and who are usually so pressed with work that they cannot if they would make up to any considerable extent their own deficiencies. The consequence frequently is that the student is put over precisely the same course, good or bad, that his teacher had pursued, and thus many defective and even pernicious methods have been perpetuated by a long succession of *pro tempore* teachers, and the student's time and the cause of classical education have often been sacrificed. Even among unquestionably competent Latin scholars, tradition and fashion have often had undue influence, and their own narrow-mindedness has sometimes been one cause of the failure, partial or complete, of classical studies to secure a really good education. Methods and objects, proper and useful enough in the sixteenth century, have been held on to in some places with almost religious bigotry; reasons for classical study, which in fact are chiefly historical, have been invented, of a necessary and *à priori* character; and the growth of modern literatures, the advance of science, and in particular of the science of language, have often failed to open the eyes of the classical zealot to the changed position of classical studies in the sum total of human knowledge.

It is probably a legitimate subject for the report, as throwing light upon *the low grade of* preparation exhibited at the examin-

ation in proportion to the time of study, to consider some of the grosser abuses which have made and still make Latin studies so unfruitful as to awaken in many minds grave doubts whether they possess any utility whatever, and while stating the abuses, to point out some intrinsic difficulties which are frequently overlooked when this subject is discussed by educational theorists and would-be reformers.

Among the foremost causes of very limited reading, and consequently deficient scholarship, must be reckoned the abuse of grammar. Students have often been compelled, even in schools of the highest reputation, to spend months and years in memorizing and reviewing the Latin Grammar, and to give such an excessive amount of time to merely grammatical praxis that the amount of reading done is quite insignificant, and in fact contemptible. The proper objects for which modern languages, and indeed most ancient languages are studied, are ignored, and it would actually seem as though no more Latin was designed to be read than was necessary to illustrate the sections, and the subsections, and the sub-subsections of some favorite grammar. So much has this been the case that many a student who has spent years upon Latin is yet unacquainted with the contents of one single ancient author, and from the neglect to aim at the acquisition of a vocabulary, is unable to read a passage of new Latin without the laborious use of a dictionary. As rather a striking illustration of the cruel absurdity which has sometimes characterized Latin teaching in the particular now under consideration, may be mentioned the testimony of a prominent chemist, in another institution, who once informed a member of the Committee that though when a boy he had studied Latin at one of the leading preparatory schools of the country, he was so entirely ignorant of the language that he could remember nothing but a portion of a long list of exceptions to one of the rules of prosody. He had studied Latin for a year, had memorized with little or no reading the bulk of Andrews & Stoddard's Latin Grammar, and all he could remember was a portion of Exception 2d, Subdivision 22 of Section 229, to the effect that *barbarus* and thirty-one other words do not make their penults long before *-rus*, *-ra* or *-rum*. It should be added that of these thirty-two words, none are defined in the grammar, and ten of them are of such infrequent occurrence that many an excellent Latin scholar would need to look them up in his dictionary if he should meet them in his reading. That the failure in this case to learn more Latin was due to any natural

deficiencies in the boy himself is sufficiently refuted by the fact that he has become a proficient in at least two modern languages, and has read freely in their literatures; but the early disgust he had conceived for Latin had prevented his ever resuming the study of this language, though he often felt the need of some acquaintance with it. Other significant illustrations might be given. Especially has the study of the syntax of the subjunctive mood in Latin, and of the case-system in Greek, consumed time and attention that could have been far better employed. Even if the theories, assumed by grammarians, of the origin of verbal and case forms had been correct, it was a faulty method of teaching language to require regularly the analysis of the supposed conception in a writer's mind which led to the employment of them. Formal analysis and conscious mental action are probably far less efficient in the study of language—certainly with young students—than imitation and unconscious induction. But, in fact, the science of language has shown that very much on which the last generation of classical students have been laboriously drilled is mere rubbish.

It cannot be denied, indeed, that a certain kind of training is secured by this pernicious and wasteful method, and this training, it is believed, is what may fairly be supposed to be meant when the preëminent value of Latin study as a means of mental discipline is asserted. No doubt, the careful study of the grammar of any language trains and develops some of the faculties of the mind, especially the power of subtle discrimination and readiness in the application of general rules; yet such training can be just as effectually secured when this end is subordinated to the learning of the language, so far as is necessary for at least the mastery of the contents, the style, and the individuality of certain leading authors, and when the discipline is allowed to come of itself, as an incidental though inevitable consequence upon thorough study. A practical reaction against excessive grammatical study, as has been mentioned above, has taken place of late among classical scholars themselves, and it is probable that more correct and rational methods are likely to be followed.

This abuse of grammar has been due, in part, it is believed, to the fact, that many of those engaged in classical teaching have found it an easier and pleasanter subject for themselves than to aim at the reading and illustration of authors. An intelligent person of adult years, though not familiar to any considerable extent with Roman authors, or Roman history and antiquities,

with far less and a different kind of labor than the acquisition of such knowledge requires, may become an acute grammarian, and will be quite likely to direct the attention of his pupils to this subject as it is most familiar and congenial to himself. The boy, therefore, whose active memory could rapidly acquire a large vocabulary, but whose mental immaturity disqualifies him in a measure for the logical distinctions of higher syntax, makes imperfect progress in his studies, and perhaps abandons them at last in disgust, and denounces them as useless.

Another circumstance, somewhat connected with the foregoing, has often led to failure or to quite inadequate results in classical studies. It is often supposed that to become a good classical scholar, one should begin these studies very early. There is reason to believe that this is a grave error, and that much time is lost by it. A course of Latin study, it is true, could be made suitable for a very early age, and in those days when facility in speaking and writing Latin, as well as reading it, was a prominent object, the study almost necessarily began early. But a complete change of conditions would suggest a complete change of methods. When, indeed, it is considered how much there is of difficulty in the mass of Latin authors; the great elaboration and brevity of their style; the capacity of the language for involved and intricate construction, which literary fashion encouraged, and sometimes exaggerated; and add to all this the difficulty arising from subject-matter wholly strange to a modern reader—strange in theology, in philosophy, in law, and in fact in everything representative of the civilization of the people: it does seem that it would be judicious to allow a boy to attain some considerable mental maturity, to awaken his literary sense by some acquaintance with his own literature, and to train his linguistic faculties by the study of his own on some other modern language, before requiring him to face a combination of difficulties so formidable. It is believed that it would be far more economical of time, and in every way more advantageous, if the reading of Latin authors was postponed a few years later than is now the custom. Of course, if one should wish, the elements of the Latin Grammar, the inflections and the principal rules of syntax, could be learned early, and simple authors could be read. The position of the Report is merely that the representative Roman authors, from which any extensive knowledge of Latin is to be derived, and any correct conception of Roman literature obtained, should come considerably later than is now the case. Professor Madvig, in the preface to his Latin Grammar, expresses

the opinion that in Europe time is lost from beginning Latin study too early, though the period he suggested for beginning it is earlier than that contemplated in the report.

The wide incompetence of classical teachers is another cause,—temporary probably, but very much to be regretted,—of unsuccessful classical study. Only those, perhaps, who have had considerable experience in conducting college entrance examinations can realize this in its full extent; but the knowledge of the fact is by no means confined to them. Able and experienced scholars who are at the head of various preparatory schools scattered throughout the land, find this one of the most formidable difficulties they are obliged to encounter in giving efficiency to the institutions under their charge. Of course this state of things cannot be so noticeable in New England as in other parts of the country. Aside from the fact, intimated above, that so many classical teachers are young college graduates, there are many academies, select schools and public schools in which the bulk of the higher teaching is done by one man. He does this, perhaps, year after year, beginning probably with only general attainments, which subsequent reading does little to advance. It cannot be expected that much efficient teaching of any kind can be done under such circumstances, still less in a language so difficult as the Latin, and where such wide and varied reading are necessary for the elucidation and illustration of a single author.

The extremely critical character of much of the classical study, and the consequent neglect to encourage and form the habit of cursive reading, as it has been called—rapid, and intelligent, but necessarily uncritical reading—leads many to suppose that ancient authors can be profitably read only with the utmost labor, and with constant employment of all critical apparatus. Such a severe standard of thoroughness is held up as renders any wide reading impossible, unless it be the sole work of a life-time. If one were to read his native English authors with the same degree of minute attention as is sometimes given to every sentence or word of Homer or Virgil, far fewer than now would ever get through "Paradise Lost," as but few American students ever do read the entire Iliad or the Æneid; Shakspere could only be read (as the Greek and Roman drama usually is) in specimen plays, and any liberal knowledge of English literature would become confined to professional English scholars alone. This cursive reading, though difficult, would be quite practicable, even in a preparatory course. The student might at least attain a conception of the nature and

utility of it, and at a more advanced stage of study he could profitably follow it either in the class-room or in his private reading; whereas now, the private study of ancient authors, from the supposed necessity of very critical reading, is seldom practiced, even by the most diligent and ambitious students.

The wide diffusion, too, of very literal English translations of those ancient authors most commonly read has been a powerful cause of imperfect scholarship; but as it may be supposed that this operates to a very limited extent in the early stages of study, it is enough in this place to make only allusion to it. In teaching many authors, the consciousness that a large portion of every class make more or less use of these translations,—which not infrequently are inaccurate and almost always inadequate,—causes the instructor great perplexity. It becomes a work of greatly increased difficulty to develop a power of original and independent analysis, on which any real mastery and appreciation of the author studied depend. Of course, the coöperation of two or more of the causes that have been enumerated, is to be expected, and rarely is one found to exist alone. It is easy to see that their combined influence will explain much of the ignorance that prevails among Latin students, even after years of study. And it is probable that many a classically trained student, in taking up the study of modern languages, has lost time and courage while attempting to follow some method of study he had derived from his experience in the ancient languages.

One further statement is necessary, of a circumstance often overlooked. The great increase within half a century in the number of subjects of educational value has led to the custom of engrafting on the old curriculum a large number of new studies. This has so reduced the time allotted to the classics that it is impracticable to attain those beneficial results which they are fitted to produce. This new composite course of study, in which the classics occupy considerably less than half the time, sometimes less than *one-third* of the time, is still called "The Classical Course," though the Classics have been virtually displaced. The student perhaps learns how to read Greek and Latin, and is then set at some new subject, leaving the authors for the reading of which so laborious and long a preparation has been made quite unread. The study is abandoned at the very point when its utility and disciplinary value would be most manifest. Of course such a procedure would discredit any branch of study.

It may be further added, in conclusion of this part of the subject under consideration, that no curriculum can probably ever be devised that shall secure wholly satisfactory results. The failure of one course of study with one individual or many proves nothing till it be clear that these persons were capable, as very many notoriously are not, of the continuous and cumulative study which is necessary for proficiency in any subject whatever. Even in England, where fashion has kept up a devotion to classical studies not common elsewhere, and where pecuniary and other powerful inducements to pursue them exist, it is stated, by a distinguished English classical scholar, that the majority of students do not acquire any thorough knowledge of the subject, and seldom rise to the point of critical literary appreciation of ancient authors. But it does not follow that this failure is due to the nature of the subjects studied. It may fairly be attributed in part to imperfect methods, in part to the fact that mental capacity is the exception and not the rule.

The Committee, in concluding their report, cannot refrain from expressing the conviction that the rigorous exaction of a fair knowledge of Latin, as a condition precedent to admission into the Scientific School, will not only be of great advantage in the student's subsequent studies, but will benefit the cause of general education, and will be hailed with satisfaction, as well by teachers of Latin as by all who are opposed to lowering the standard of acquirement in courses of educational study leading to a degree, and to the dissemination of false notions among the uneducated classes. In many parts of the country, in consequence of the imperfect results of classical study, as it has too frequently been conducted, there has arisen a sentiment utterly hostile to such study; and men of station and of influence, sometimes from mistaken convictions, and sometimes, it must be believed, from a spirit of educational demagogism, have decried Latin and Greek as useful for no purpose whatever. This might have been more harmless, if some substitute for them had been offered, equally exacting and disciplinary: but in most cases no such substitute has been presented; and so these leveling and iconoclastic movements have availed chiefly to narrow the range of thought and knowledge of the student, to encourage that natural indolence and incuriosity which often leads a young man to "elect" one course in preference to another merely because it is reputed to be easier, to foster ignorance and sciolism, and to spread false and pernicious doctrines in regard to the true nature and objects of education. Doubtless, there is no magic in Latin, and

few purely educational advantages can be claimed for it that could not be claimed for several other languages and literatures, ancient and modern; but considered merely as an instrument of investigation, wholly indispensable to some classes of students, and serviceable to many if not to all classes, it must be allowed to possess an unquestioned utility, and to have a practical value, even in the lowest sense of these greatly abused words. The kind of knowledge and the extent of it needed, as is the case with every other subject, will of course vary with the special views and the tastes of individuals, as has been already indicated above.

Great ignorance and misconception in regard to the whole subject of literary and linguistic studies prevail in the minds of many persons, who are not, however, backward in expressing dogmatic views in regard to them. It is, in consequence, all the more essential that the Scientific School should do all that lies in its power, and exert any influence it may have, however slight, toward the spreading in the community of rational and philosophical views on the subject of education. The petty and prejudiced spirit which has at times been manifested by classical zealots toward science should never be allowed to find a counterpart in the attitude of men of science toward literary and linguistic study; yet this must inevitably be the case if the broad general principles which lie at the basis of all education are not fully recognized and acted upon in the institutions of which they have the control. It does not follow because new branches of learning of great interest and value have been developed, that the study of what in the past has been held useful must be abandoned. That education, whether it be classical or scientific, which so narrows for any man the field of vision that he can see little merit or utility in branches outside of his own department, must be looked upon as a failure. There is no saving virtue in any course of study or any kind of knowledge. The denial of the benefits of classical study on the part of scientific men would be as great a blunder, as has been the denial of the value of scientific study by devotees of the classics. All knowledge has claims upon us, and the cause of education in general suffers when any branch of learning is disparaged or misrepresented. It is gratifying to be able to believe that the Scientific School, by requiring some knowledge of Latin as a requisite for admission, though doing so for its own purposes and its own advantage, is yet sustaining the cause of sound education, and contributing in no slight degree to the broader intellectual development of those whose instruction has been intrusted to

its charge, by placing them in a measure in sympathetic and intelligent relations to other leading departments of knowledge, in which few of them can ever hope to make any extensive acquisitions.

In conclusion, the Committee would make to the Governing Board the two following specific recommendations:

1st. That six books of Cæsar's Commentaries, or an equivalent amount in some other author or authors, be hereafter regarded as the minimum amount which will be accepted in the Latin examination, and that this requirement be rigidly enforced.

2nd. That after the Examination of 1873, an examination be also required in some text-book for the translation of simple exercises from Latin into English.

All of which is respectfully submitted,

A. S. WHEELER,
W. D. WHITNEY,
T. R. LOUNSBURY.

Anniversary.

The anniversary exercises were held in Sheffield Hall, on the evening of Monday, July 8, 1872. Eight theses were selected for public reading.

The candidates for degrees, with the subject of their theses, are given in the following schedule. Those marked with an asterisk were read in the evening.

CANDIDATES FOR DEGREES.

WITH THE SUBJECTS OF THEIR GRADUATION THESES.

CIVIL ENGINEERS. (2)

HORACE ANDREWS, Ph.B., *Tarrytown, N. Y.* Design of a Parabolic Roof Truss.

MANSFIELD MERRIMAN, Ph.B., *Plantsville.* Design for a Railway Draw-bridge.

BACHELORS OF PHILOSOPHY. (22)

*JACOB JACKSON ABBOTT (Select), *Yarmouth, Me.* On Man in Pre-Historic Times.

JAMES PETER BOGART (Engineering), *New Haven.* On the New Haven Sewage Plan.

*WHEELER DEFOREST EDWARDS, B.A., College of City of N. Y. (Engineering), *New York City.* On the East River Bridge.

JOSEPH RIDGWAY GAWTHROP (Engineering), *Northbrook, Pa.* On the New York and New Haven Railway Bridge over the Housatonic.

WILLIAM SAUNDERS GREEN (Chemistry), *Cincinnati, O.* On the Production of Boiler-Plate Iron from the Bloom Forge Iron Works, at Portsmouth, O.

GEORGE WESSON HAWES (Chemistry), *Boston, Mass.* On Education for Mercantile Life.

*DANIEL WEBSTER HERING (Engineering), *Johnsville, Md.* On Water-Pressure Engines.

*CHARLES LOUIS JOHNSON (Select), *Ansonia.* On the Monosyllabism of the English Language.

CASSIUS WILLIAM KELLY, B.A, Yale College (Engineering), *Erie, Pa.* On the Problem of the Rafters.

*SAMUEL TREVOR KNAPP (Select), *New York City.* On the Land Tenure and other Institutions of the Dutch upon the Hudson River.

HARRISON WHEELER LINDSLEY (Engineering), *New Haven.* Review of an Iron Bowstring Girder Bridge near New Haven.

*FRANK OSCAR MAXSON (Engineering), *Norwich.* On Pneumatic Caissons.

ROBERT DOUGLAS MILHOLLAND MAXWELL (Select), *Wilmington, Del.* A Cartographic Study of the Peninsula between Delaware and Chesapeake Bays.

GEORGE NOYES MILLER (Select), *Wallingford.* An Investigation, partly from Original Sources, as to whether Eleazar Williams was a Bourbon.

THOMAS PERKINS NEVINS (Engineering), *Waterford.* A Partial Examination of the Works of the New Haven Water Company.

*THEOPHIL MITCHELL PRUDDEN (Medical), *New Haven.* On the Anatomy and Habits of the Larger Fiddler Crab (*Gelasimus Minax*).

THOMAS HUBBARD RUSSELL (Medical), *New Haven.* On the Anatomy of the American Lobster.

CHARLES AUSTIN TIBBALS (Select), *Brooklyn, N. Y.* On the Rise of the British Drama.

DANIEL WARDWELL WARDWELL (Select), *Rome, N. Y.* On the Text of Chaucer.

*FREDERICK FLOYD WELD (Engineering), *Guilford.* On the Burleigh Air-Compressor and Rock-Drill.

WILLIAM BRENTON WELLING (Select), *New York City.* On the Influence of Monasticism upon Education in England.

THOMAS WALLACE WRIGHT, B.A., Univ. of Toronto (Engineering), *Galt, Canada.* An Investigation of New Formulæ for Finding the Strains in Continuous Girders uniformly Loaded.

Prizes.

The following prizes were announced at the anniversary.

The value of each of these is $10.

CLASS OF 1872

For excellence in Mineralogy, the prize awarded to GEORGE W. HAWES, *Boston, Mass.*

For the best collection of the Compositæ described in Gray's Manual of Botany, the prize awarded to THEOPHIL M. PRUDDEN, *New Haven.*

For the best collection illustrating the fresh-water Zoology of New Haven and vicinity, the prize divided between THEOPHIL M. PRUDDEN, *New Haven*, and THOMAS H. RUSSELL, *New Haven*, equal in rank.

For excellence in French, the prize awarded to FRANK O. MAXSON, *Norwich.*

For excellence in Civil Engineering, the prize awarded to FRANK O. MAXSON, *Norwich*, with honorable mention of DANIEL W. HERING, *Johnsville, Md.*

CLASS OF 1873.

For excellence in the Mathematics of Junior Year, two prizes awarded, one to WILLIAM A. JENKS, *Brookville, Pa.*, and one to WILLIAM L. SCAIFE, *Pittsburgh, Pa.*

CLASS OF 1874.

For excellence in all the Studies of Freshman Year, the prize divided between ALLEN B. HOWE, *Troy, N. Y.*, and HENRY HUN, *Albany, N. Y.*

For excellence in German, the prize awarded to ALLEN B. HOWE, *Troy, N. Y.*

For excellence in Mathematics, the prize awarded to IRVING L. HOLT, *Meriden.*

For excellence in Physics, the prize awarded to HENRY HUN, *Albany, N. Y.*

For excellence in Binn's Orthographic Projection, the Prize awarded to CHARLES J. MORSE, *Poland, O.*

PROGRAMME OF STUDIES,

AND

CATALOGUE,

For the College Year 1872–1873.

Corporation of Yale College.

THE GOVERNOR AND LIEUTENANT GOVERNOR OF THE STATE ARE *ex-officio* MEMBERS OF THE CORPORATION.

PRESIDENT.

REV. NOAH PORTER. D.D., LL.D.

FELLOWS.

HIS EXCELLENCY MARSHALL JEWELL, HARTFORD.
HIS HONOR MORRIS TYLER, NEW HAVEN.
REV. LEONARD BACON, D.D., LL.D., NEW HAVEN.
REV. THEODORE D. WOOLSEY, D.D., LL.D., NEW HAVEN.
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REV. EDWIN R. GILBERT, D.D., WALLINGFORD.
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REV. DAVID S. BRAINERD, M.A., LYME.
REV. MYRON N. MORRIS, M.A., WEST HARTFORD.
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REV. SAMUEL C. WILLARD, M.A., COLCHESTER.
HON. HENRY B. HARRISON, M.A., NEW HAVEN.
HON. WILLIAM WALTER PHELPS, M.A., NEW YORK CITY.
JOSEPH E. SHEFFIELD, M.A., NEW HAVEN.

SECRETARY.

FRANKLIN B. DEXTER, M.A.

TREASURER.

HENRY C. KINGSLEY, M.A.

GOVERNING BOARD.

APPOINTED BY THE CORPORATION OF YALE COLLEGE.

President.

REV. NOAH PORTER, D.D., LL.D., — 31 Hillhouse av.

Professors.

ARRANGED IN THE ORDER OF THEIR GRADUATION.

WILLIAM A. NORTON,
Civil Engineering and Mathematics. — 72 Prospect st.

HESTER S. LYMAN,
Physics and Astronomy, Theoretical and Practical. — 88 Trumbull st.

WILLIAM D. WHITNEY,
Linguistics and French. — 246 Church st.

WILLIAM P. TROWBRIDGE,
Dynamic Engineering (HIGGIN *Professor*). — Prospect st.

GEORGE J. BRUSH (Executive Officer),
Mineralogy. — 14 Trumbull st.

SAMUEL W. JOHNSON,
Agricultural and Analytical Chemistry. — 54 Trumbull st.

WILLIAM H. BREWER,
Agriculture (NORTON *Professor*). — 246 Orange st.

DANIEL C. EATON,
Botany. — Sachem st., c. Prospect.

THOMAS R. LOUNSBURY,
English. — 22 Lincoln st.

OTHNIEL C. MARSH.
Palæontology. — 9 College st.

FRANCIS A. WALKER,
Political Economy and History. — 30 Trumbull st.

OSCAR D. ALLEN,
Metallurgy. — 28 Clark st.

ADDISON E. VERRILL,
Zoölogy and Geology. — 148 College st.

LECTURERS, INSTRUCTORS AND ASSISTANTS.*

ADDITIONAL TO THE GOVERNING BOARD.

JOHN E. CLARK,
Mathematics. N. S. H.

ALBERT S. WHEELER,
German. 710 Chapel st.

MARK BAILEY, of the Academical Department,
Elocution. 185 Temple st.

JOHN H. NIEMEYER, Professor in the Yale School of the Fine Arts,
Free Hand Drawing. 93 Olive st.

LOUIS BAIL,
Mechanical and Topographical Drawing. 43 Park place.

F. R. HONEY,
Orthographic Projection. 42 Prospect st.

SIDNEY I. SMITH,
Zoölogy. 148 College st.

DANIEL H. WELLS,
Analytical and Descriptive Geometry. 99 Bradley st.

JULES LUQUIENS,
French. 96 York st.

OSCAR HARGER,
Palæontology. (4 TR.) 42 S. H.

EDWARD S. BREIDENBAUGH,
Chemistry. S. H.

CHARLES S. HASTINGS,
Physics. 90 Grove st.

HORACE ANDREWS,
Surveying. 8 York sq.

DANIEL H. PIERPONT,
Surveying. 145 Olive st.

THEOPHIL M. PRUDDEN,
Chemistry. S. H.

* The Professorship of Military Science is temporarily vacant.

SHEFFIELD SCIENTIFIC SCHOOL.

GRADUATE STUDENTS.

) Jackson Abbott, PH.B.	*New Haven,*	29 Prospect st.
ce Andrews, C.E.	*Tarrytown, N. Y.*	8 York sq.
y Prentiss Armsby, Worcester Free Ind. Institute.	*Millbury, Mass.*	172 George st.
ander H. Bezjian, 'rof. of Physical Science in the Central Turkey College,	*Aintab, Syria,*	120 College st.
ard Swoyer Breidenbaugh, M.A. 'a. College,	*Gettysburgh, Pa.*	S. H.
ge Benjamin Chittenden, PH.B.	*New Haven,*	73 Trumbull st.
le B. Craig, B.A.	*Pittsburgh, Pa.*	8 Lock st.
les Burritt Curtiss, B.A. Beloit College,	*Dover, Ill.*	1 Winthrop av.
Leadley Dagg, B.A. Bethel College, Ky.	*Hopkinsville, Ky.*	45 Crown st.
cis Urquhart Downing, B.A.	*New Haven,*	83 Olive st.
les Benjamin Dudley, B.A.	*New Haven,*	460 Chapel st.
s Ridgway Gawthrop, PH.B.	*Northbrook, Pa.*	27 Mansfield st.
r Harger, M.A.	*Oxford,*	42 S. M.
les Sheldon Hastings, PH.B.	*Hartford,*	90 Grove st.
ge Wesson Hawes, PH.B.	*Boston, Mass.*	S. H.
y Allen Hazen, B.A. Dartmouth College,	*New Haven,*	28 Ward st.
iam Hale Herrick, B.A. Williams College,	*Clarendon, Vt.*	125 Dwight st.
ard Hopkins Jenkins, B.A.	*Falmouth, Mass.*	122 Park st.
k Fanning Jewett, B.A.	*Norwich,*	8 Lock st.
iam Knowlton Kedzie, B.S. Mich. Agric. College,	*Lansing, Mich.*	S. H.
ph Frederick Klein, PH.B.	*New Haven,*	86 Nicoll st.
ison Wheeler Lindsley, PH.B.	*New Haven,*	132 Olive st.
ph Taplin Lovewell, B.A.	*Whitewater, Wisc.*	
nas William Mather, PH.B.	*New Haven,*	26 Beers st.
el Hobart Pierpont, PH.B.	*North Haven,*	145 Olive st.
phil Mitchell Prudden, PH.B.	*New Haven,*	S. H.
ard Allen Wilson, B.A.	*St. Louis, Mo.*	129 College st.
nas Wallace Wright, M.B., B.A., Toronto University,	*Galt, Canada,*	S. H.

GRADUATES, 28.

SENIOR CLASS.

John Winthrop Auchincloss,	*New York City,*	11 College st.
Edgar Henry Summerfield Bailey,	*Middlefield,*	125 Dwight st.
Alvah Weed Brown,	*Englewood, N. J.*	25 Prospect st.
Moses Bulkley,	*Brooklyn, N. Y.*	29 Prospect st.
Charles Albert Burt,	*Wallingford,*	169 Temple st.
William Righter Comings,	*New Britain,*	177 Temple st.
William Allen Cowles,	*New Haven,*	19 Park st.
Charles Adams Cragin,	*Wallingford,*	169 Temple st.
Robert John Currey,	*San Francisco, Cal.*	122 College st.
Annis Merrill Doolittle,*	*Wallingford,*	129 College st.
Harry Taylor Gause,	*Wilmington, Del.*	84 Wall st.
Edward Julius Hall,	*Buffalo, N. Y.*	73 Trumbull st.
Henry Sheaff Hoyt,	*Staatsburgh, N. Y.*	488 Chapel st.
Robert Jaffray,	*New York City,*	143 College st.
William Hampden Jenks,	*Brookville, Pa.*	22 York sq.
George Christopher Moore,	*Birmingham,*	31 Trumbull st.
Charles Tombling Noonan,	*Milwaukee, Wisc.*	64 Whitney av.
William Josiah Parks,	*Brooklyn, N. Y.*	136 College st.
Benjamin Pomeroy,	*Southport,*	122 College st.
Samuel Rockwell,	*Bridgehampton, N. Y.*	177 Temple st.
Amory Edwards Rowland,	*Brooklyn, N. Y.*	29 Prospect st.
Edgar Camp Savage,	*West Meriden,*	25 Prospect st.
William Lucien Scaife,	*Pittsburgh, Pa.*	8 Lock st.
Alfred Lewis Sellers,	*West Chester, Pa.*	87 N. M.
Charles Thompson Smith,	*New York City,*	25 Prospect st.
Lewis Rodney Taylor,	*Hamilton, Va.*	227 Crown st.
Henry Goodrich Wolcott,	*Fishkill, N. Y.*	134 College st.

SENIORS, 27.

* Deceased.

JUNIOR CLASS.

s Belknap Beach,	*West Hartford,*	165 Temple st.
Edward Beckwith,	*New Haven,*	64 Whitney av.
Taylor Belcher,	*Garrison's, N. Y.*	33 Prospect st.
Cook Brewster,	*Norwich,*	33 Prospect st.
l Brush,	*Greenwich,*	127 College st.
Bucklin Claflin,	*Boston, Mass.*	159 Temple st.
ck Bowman Crawford,	*Chicago, Ill.*	33 Prospect st.
n Edwards,	*Northampton, Mass.*	11 College st.
Howard Fitch,	*New Haven,*	58 Olive st.
Horace Forbes,	*Cromwell,*	20 York sq.
Gale,	*New York City,*	169 Temple st.
Houtz Grove,	*Fredericksburg, Pa.*	23 Prospect st.
Smoote Hall,	*Mobile, Ala.*	165 Temple st.
t Gilpin Hazard,	*West Chester, Pa.*	35 High st.
Davenport Head,	*St. Paul, Minn.*	94 Grove st.
s Daniel Hill,	*Calais, Me.*	432 Chapel st.
Leroy Holt,	*Rockville,*	105 Park st.
Brewer Howe,	*Troy, N. Y.*	138 College st.
Hun,	*Albany, N. Y.*	23 Prospect st.
o M. Johnson,	*Rochester, Mass.*	23 Prospect st.
Jarvis Kellogg,	*Milford,*	129 College st.
Hittell Killinger,	*Lebanon, Pa.*	173 Temple st.
r Livingston,	*N. Y. City,*	145 York st.
n Pitt Lynde,	*Milwaukee, Wisc.*	159 Temple st.
n McGrath,	*Bridgeport,*	16 Park st.
s James Morse,	*Poland, O.*	46 Hillhouse av.
Smith Needham,	*Louisville, Ky.*	11 College st.
Gregory Newhall,	*San Francisco, Cal.*	107 York st.
s Ernest Osborn,	*Norwalk,*	227 Crown st.
d Deane Arden Parrott,	*Greenwood Works, N. Y.*	159 Temple st.
ns Victor Pendleton,	*Bozrah,*	8 Lock st.
v Peters,	*New York City,*	159 Temple st.
Coffin Power,	*Hudson, N. Y.*	83 Olive st.
Brewster Platt,	*Waterbury,*	109 Elm st.
n Spencer Pratt,	*New Haven,*	17 Hazel st.
n Henry Reynolds,	*New Haven,*	129 York st.
n Rockwell,	*Bridgehampton, N. Y.*	177 Temple st.

William Rodman,	*New Haven*,	491 Chapel st.
William Arthur Rogers,	*Covington, Ky.*	503 Chapel st.
Charles Waterman Smith,	*Hartford*,	90 Grove st.
William von Steinwehr,	*New Haven*,	117 Elm st.
John Muirhead Stewart,	*Peekskill, N. Y.*	19 Park st.
Francis Hill Stillman,	*Plainfield, N. J.*	8 Lock st.
Jared Sidney Torrance,	*Gowanda, N. Y.*	165 Temple st.
William Richardson Upham,	*Yonkers, N. Y.*	159 Temple st.
Simeon Harrison Wagner,	*West Haven*,	353 State st.
John Charles Weber,	*New York City*,	165 Temple st.
Charles Bell Willcox,	*Stamford*,	93 Olive st.

JUNIORS, 48.

FRESHMAN CLASS.

ɜs Henry Alling,	*Birmingham,*	96 York st.
D. Barrett,	*Amenia, N. Y.*	80 Broadway.
Bradstreet Bradford,	*Middletown,*	3 Home pl.
Gilbert Bramley,	*Bovina, N. Y.*	172 Temple st.
ım McCulloh Brown,	*Brookline, Mass.*	143 York st.
e Loomis Brownell,	*East Haddam,*	31 Prospect st.
A. Browning,	*North Stonington,*	120 College st.
ɜs Stewart Bunce,	*Glastenbury,*	8 Elm st.
ıon Taylor Burr,	*Westport,*	116 College st.
Erwin Burton,	*Erie, Pa.*	134 College st.
Taylor Chambers,	*Wilmington, Del.*	35 High st.
ɔd Benjamin Chandler,	*Woodstock,*	20 York sq. pl.
Henry Chapman,	*New York City,*	48 College st.
' Grant Cheney,	*South Manchester,*	90 Grove st.
ım Alexander Christie,	*Newport, R. I.*	29 Prospect st.
r Eugene Clarke,	*Batavia, N. Y.*	159 Temple st.
ɔn Platt Cleaveland,	*New Haven,*	140 York st.
e Rufus Cooley,	*Hamden,*	353 State st.
ric Augustus Corning,	*Hartford,*	33 Prospect st.
bers McKibbin Craig,	*Alleghany City, Pa.*	8 Lock st.
Cunningham,	*Pittston, Pa.*	149 College st.
' Sheldon DeForest,	*Birmingham,*	108 York st.
ɜs Dickinson,	*Fordham, N. Y.*	205 Orange st.
Alfred Ethridge,	*Rome, N. Y.*	11 College st.
ɜs William Fenn,	*Portland, Me.*	7 Library st.
ric Hodgeman Foote,	*Port Henry, N. Y.*	23 Prospect st.
ɜs Hamilton Fox,	*Lansingburgh, N. Y.*	147 York st.
. Freeland,	*New York City,*	120 College st.
r Henry Gager,	*Coventry,*	209 Elm st.
t Francis Gaylord,	*Sherman,*	E., D. H.
ʒston Gifford,	*Jersey City, N. J.*	116 College st.
Emile Addison Goll,	*Newark, N. J.*	88 Wall st.
Holabird Grant,	*Glastenbury,*	8 Elm st.
Starr Griffing,	*New Haven,*	114 Chapel st.
ım Cornelius Hall,	*Buffalo, N. Y.*	73 Trumbull st.
' Mortimer Hastings,	*Oswego, N. Y.*	132 College st.
. Pell Haven,	*New York City,*	33 Prospect st.
ɜs Hildebrand,	*New Haven,*	16 Chestnut st.
ım Read Howe,	*Orange, N. J.*	64 Whitney av.

Julian Kennedy,	*Struthers, O.*	91 Ashmun st.
Edward Austin Kent,	*Buffalo, N. Y.*	159 Temple st.
George Reinard Kleeberger,	*Apple River, Ill.*	6 College st.
Wells Cushman Lake,	*Lake Forest, Ill.*	72 High st.
Charles Purdy Lindsley,	*New Haven,*	132 Olive st.
Blanchard Lynde,	*Milwaukee, Wisc.*	33 Prospect st.
Albert Sutton Macgregor,	*New York City,*	11 College st.
William James McKee,	*Madison, Ind.*	11 College st.
Clarence Fake McMurray,	*Lansingburgh, N. Y.*	147 York st.
Burton Mansfield,	*New Haven,*	50 Lyon st.
Charles Aldworth Maybury,	*Norwalk,*	76 High st.
John Daniel Mersereau,	*Portville, N. Y.*	31 Prospect st.
Arthur Edward Nichols,	*Yonkers, N. Y.*	11 College st.
John Charles Olmsted,	*New York City,*	189 Church st.
John Robert Paddock,	*Cheshire,*	154 St. John st.
Frederic Noah Pease,	*Ellington,*	22 York sq.
William Edward Peirce,	*Raleigh, N. C.*	11 Grove st.
Dwight Edward Pierce,	*New Haven,*	120 High st.
George White Polk,	*Odessa, Del.*	72 Howe st.
William Arthur Pratt,	*New Haven,*	88 Howe st.
William Shugard Righter,	*Newark, N. J.*	177 Temple st.
Walter Coe Roberts,	*New Haven,*	8 Brown st.
William Babcock Sawyer,	*Buffalo, N. Y.*	116 College st.
James Alvin Scott,	*Naugatuck,*	172 George st.
Richard Sharpe,	*Eckley, Pa.*	72 Howe st.
Clarence Hoyt Stilson,	*Cleveland, O.*	96 York st.
Howard Steadman Talcott,	*Hartford,*	33 Prospect st.
William Allen Tremaine,	*Hartford,*	18 Mansfield st.
Charles Wall Truslow,	*New York City,*	22 York sq.
Frederick Moncrieff Turnbull,	*Hartford,*	18 Mansfield st.
George L. Upham,	*Yonkers, N. Y.*	92 Grove st.
Thomas Alfred Vernon,	*Brooklyn, L. I.*	7 Library st.
William Oakley Wallace,	*Ansonia,*	31 High st.
Alonzo Earl Wemple,	*Brooklyn, L. I.*	149 College st.
William Rodman Wharton,	*Germantown, Pa.*	432 Chapel st.
Alfred Newton Wheeler,	*Southford,*	59 Wooster st.
Henry Stacy Whipple,	*Birmingham,*	96 York st.
Edward Luther White,	*Waterbury,*	31 Prospect st.
George Horace Wilcox,	*West Meriden,*	25 Prospect st.
Frederick Wood,	*Norwalk,*	116 College st.
Kenjiro Yamagawa,	*Japan,*	11 Grove st.

ECIAL STUDENTS NOT CANDIDATES FOR A DEGREE.

ı Benner,	*Astoria, N. Y.*	164 York st.
ı Attwater Bostwick,	*New Haven,*	162 Olive st.
ı B. Caldwell,	*Louisville, Ky.*	106 Wall st.
Moses Child,	*Woodstock,*	20 York sq. pl.
Henry Chittenden,	*New Haven,*	23 Humphrey st.
e Cogswell,	*Marble Dale,*	136 College st.
ɒ James Dougherty,	*Washington, Ill.*	168 George st.
Elliot Gregory,	*New York City,*	134 College st.
ı Wilson Hall,	*Killingworth,*	14 Park st.
ı Lyman,	*Middlefield,*	Middlefield.
ɔk Anthony Marks,	*Wallingford,*	169 Temple st.
Soulé Phelps,	*East Windsor,*	Wallingford.
ɒ James Rattle,	*Cleveland, O.*	96 York st.
ıld Rogers,	*New York City,*	120 College st.
oward Sherman,	*New Haven,*	Whitneyville.
Henry Smith,	*Plainville,*	22 York sq. pl.
ı Tsuda,	*Kumamoto, Japan,*	138 College st.
Traquair Tyson,	*Philadelphia, Pa.*	217 Crown st.

SPECIAL STUDENTS, 18.

SUMMARY.

GRADUATES,	28
SENIORS,	27
JUNIORS,	48
FRESHMEN,	80
SPECIAL STUDENTS,	18
TOTAL,	201

SHEFFIELD SCIENTIFIC SCHOOL.

I.

Objects.

The Sheffield Scientific School is devoted to instruction and researches in the mathematical, physical, and natural sciences, with reference to the promotion and diffusion of science, and also to the preparation of young men for such pursuits as require especial proficiency in these departments of learning. It is one of the Departments of Yale College, like the law, medical, theological and art schools, having its separate funds, buildings, teachers, and regulations, but governed by the Corporation of Yale College, which appoints the professors and confers the degrees. It is, in part, analogous to the academic department or classical college, and, in part, to the professional schools.

The instruction is intended for two classes of students:—

I. Graduates of this or of other Colleges, and other persons qualified for advanced or special scientific study.

II. Undergraduates who desire a training chiefly mathematical and scientific, in less part linguistic and literary, for higher scientific studies, or for various other occupations to which such training is suited.

II.

History and Organization.

The School was commenced in 1847. In 1860, a convenient building and a considerable endowment were given by Joseph E. Sheffield, Esq., of New Haven, whose name, at the repeated request of the Corporation of Yale College, was afterward attached to the foundation. Mr. Sheffield has frequently and munificently increased his original gifts, and an additional building for the use of the School, the construction of which was begun by him more than a year ago, is now very near completion, and will be ready for use before the beginning of the next academic year.

In 1864, by an act of the Connecticut Legislature, the national grant for the promotion of scientific education (under the congressional enactment of July, 1862) was given to this department of Yale College, which thus became "the College of Agriculture and the Mechanic Arts for Connecticut." Since that time, and especially since the autumn of 1869, numerous liberal gifts have been received from the citizens of New Haven, and from other gentlemen in Connecticut, New York, and St. Louis, for the endowment of the School, and the increase of its collections.

The action of the State led to the designation by law of a State Board of Visitors, consisting of the Governor, Lieutenant Governor, three senior Senators, and Secretary of the State Board of Education; and this Board, with the Secretary of the Scientific School, is also the Board for the appointment of students to hold the State scholarships.

At the request of the Governing Board, the Corporation of Yale College has also appointed a Board of Councillors for the School, consisting of a number of gentlemen who have taken a deep interest in its welfare, and have assiduously labored to secure its success.

The Governing Board consists of the President of Yale College and the Professors who are permanently attached to the School. There are several other instructors associated with them, a part of whom are connected with other departments of the College.

This peculiar organization, though somewhat complex, has been a natural growth of the last twenty-five years, and it may be added that the combination of a new department, with an old and well tried institution like Yale College has advantages for both. The establishment of a college of science has relieved the academic or classical college from all pressure tending to the establishment of "partial courses" of study, and has supplemented its means of instruction by new professorships and new scientific collections; while it has rendered further service by giving to graduates of the classical department opportunities for special and systematic professional training, distinct from those afforded in the schools of law, medicine, and theology.

III.

Building and Apparatus.

Sheffield Hall is a building containing a large number of recitation and lecture rooms, a hall for public assemblies and lectures, chemical and metallurgical laboratories, a photographical room,

an astronomical observatory, museums, a library and reading room, besides studies for some of the professors, where their private technical libraries are kept. Up to a recent period it furnished sufficient accommodations for all the exercises of the School; but the rapid increase in the number of students has of late rendered it necessary to carry on much of the work of instruction in other places. To remedy this state of things, Mr. Sheffield has nearly completed a large and well-arranged building directly north of the present Sheffield Hall, which will be thoroughly furnished and ready for use by the beginning of the autumn term. A full description of this edifice can be found in the annual report for the current year.

The following is a summary statement of the collections belonging to the School:—

1. Laboratories and Apparatus in Chemistry, Metallurgy, Photography, and Zoölogy.
2. Metallurgical Museum of Ores, Furnace Products, etc.
3. Agricultural Museum of Soils, Fertilizers, useful and injurious Insects, etc.
4. Collections in Zoölogy.
5. Astronomical Observatory, with an equatorial telescope by Clark and Sons of Cambridge, a meridian circle, etc.
6. Library and reading room, containing the "Hillhouse Mathematical Library," books of reference, and a selection of German, French, English, and American scientific journals.
7. A collection of Physical Apparatus, constituting the "Collier Cabinet."
8. Models in Architecture, Geometrical Drawing, Civil Engineering, Topographical Engineering, and Mechanics; diagrams adapted to public lectures; instruments for field practice.
9. Maps and Charts, topographical, hydrographical, geological, etc.

The mineralogical cabinet of Professor Brush, the herbarium of Professor Brewer, the collection of native birds of Professor Whitney, and the astronomical instruments of Professor Lyman, are deposited in the building. Professor Eaton's herbarium, near at hand, is freely accessible.

Students are also admitted, under varying conditions, to the College and Society libraries, the College Reading Room, the Cabinet of Minerals and Fossils, the School of the Fine Arts, and the Gymnasium.

IV.

Instruction for Graduate and Special Students.

Persons who have gone through undergraduate courses of study, here or elsewhere, may avail themselves of the facilities of the School for more special professional training in the physical sciences and their applications, gaining in one, two, or three years

the degree of BACHELOR OF PHILOSOPHY, or, in two additional years of Engineering study, that of CIVIL ENGINEER, or of DYNAMICAL ENGINEER.

Or, engaging in studies of a less exclusively technical character, they may become candidates for the degree of DOCTOR OF PHILOSOPHY. The instruction in such cases will be adapted to the particular needs and capacities of each student, and may be combined with that given by the graduate instructors in other departments of the University. This degree is conferred upon those who, having already taken a Bachelor's degree, engage as students in the Department of Philosophy and the Arts for not less than two years in assiduous and successful study. It is not given upon examination to those whose studies are pursued elsewhere. The requirements for it will in some cases exact of the student more than two years of post-graduate labor; so, especially, wherever the course of undergraduate study has been, as in the Scientific School, of less than four years. The candidate must pass a satisfactory final examination, and present a thesis giving evidence of high attainment in the branches of knowledge to which he has attended. A good knowledge of Latin, German and French will be required in all cases, unless, for some exceptional reason, the candidate be excused by the Faculty. The graduating fee is ten dollars.

Subjects likely to receive special attention are suggested as follows:—

Professor NORTON will instruct in the mechanics of rigid bodies and of fluids, and in spherical astronomy, including the computation of planetary and cometary orbits.

Professor LYMAN, in the use of meridional and other astronomical instruments, and in astronomical spectroscopy.

Professor TROWBRIDGE, in the principles of thermodynamics, or the artificial generation, transfer, and utilization of heat as a source of power.

Professor BRUSH, in the analysis and determination of mineral species, and in descriptive mineralogy.

Professor JOHNSON, in theoretical, analytical and agricultural chemistry.

Professor BREWER, in agriculture and forest culture, in the use of the microscope, and in physical geography.

Professor EATON, in structural and systematic botany, including the North American flora and the description of genera and species.

Professor *MARSH, in palæ*ontology and comparative osteology.

Professor WALKER, in public finance, and in the statistics of industry.

Professor ALLEN, in analytical chemistry, and in metallurgy.

Professor VERRILL and Mr. S. I. SMITH, in zoölogy and geology.

Professor CLARK, in the general theory of equations, and in the differential and integral calculus.

The same courses of study are open, for a longer or shorter time, to graduate students who do not desire to become candidates for a degree.

The degrees of CIVIL ENGINEER and of DYNAMIC ENGINEER are conferred on Bachelors who have taken the first degree in engineering study, and who pursue specified higher courses for at least two years, sustaining a final examination, and giving evidence of their ability to design important constructions and to make the requisite drawings and calculations. The fee for each of these degrees is five dollars.

SPECIAL STUDENTS.—For the benefit of those who, being fully qualified, desire to pursue particular studies without reference to the obtaining of a degree, special or irregular students are received in most of the departments of the School (not, however, in the Select Course or in the Freshman Class).

It should be distinctly understood that these opportunities are not offered to persons who are incompetent to go on with regular courses, but are designed to aid those who, having received a sufficient preliminary education elsewhere, desire to increase their proficiency in special branches.

V.

INSTRUCTION FOR UNDERGRADUATE STUDENTS.

TERMS OF ADMISSION.—Candidates must be not less than sixteen years of age, and must bring satisfactory testimonials of moral character from their former instructors or other responsible persons.

For admission the student must pass a thorough examination in *Arithmetic*, including the Metric System; in Davies's Bourdon's *Algebra* as far as the General Theory of Equations, or in its equivalent; in *Geometry*, in the nine books of Davies's Legendre, or their equivalent; in *Plane Trigonometry*, Analytical Trigonometry inclusive; in *Geography*, *United States History* and *English Grammar*, including Spelling, and in *Latin*. In this last, six books of Cæsar's Commentaries, or their equivalent, as, for example, the prose of the first portion of Allen's Latin Reader closing

with Sallust, is the least amount which will be accepted in the examination. After the examination of 1873, a knowledge of some text-book, containing simple exercises for translation from English into Latin, will also be required.

The examinations for admission take place at Sheffield Hall, on Saturday, June 21st, and Friday, June 27th, the Saturday preceding and the Friday following Commencement; and on Wednesday, Sept. 10th, 1873. Opportunity for private examination may, in exceptional cases, be given at other times.

Candidates for advanced standing in the undergraduate classes are examined, in addition to the preparatory studies, in those already pursued by the class they propose to enter. No one can be admitted as a candidate for a degree later than at the beginning of the Senior year.

COURSES OF INSTRUCTION, occupying three years, are arranged to suit the requirements of various classes of students. The first year's work is the same for all; during the last two years the instruction is chiefly arranged in special courses.

The special courses most distinctly marked out are the following:—

(a.) In Chemistry and Metallurgy;
(b.) In Civil Engineering;
(c.) In Dynamic (or Mechanical) Engineering;
(d.) In Agriculture;
(e.) In Natural History;
(f.) In studies preparatory to Medical Studies;
(g.) In studies preparatory to Mining;
(h.) In Select studies preparatory to other higher pursuits, to business, etc.

The arrangement of the studies is indicated in the annexed scheme.

FRESHMAN YEAR.—INTRODUCTORY TO ALL THE COURSES.

FIRST TERM—*German.*—Whitney's Grammar and Reader. *English.*—Hadley's Brief History of the English Language; Exercises in Composition. *Mathematics.*—Davies's Analytical Geometry, and Spherical Trigonometry. *Physics.*—Atkinson's Ganot, with experimental lectures. *Chemistry.*—Eliot and Storer's Manual; Laboratory practice. *Elementary Drawing.*—Practical Lessons in the Art School.

SECOND TERM—*Language, Physics, Chemistry, and Drawing.*—As stated above. *Mathematics.*—Church's Descriptive Geometry. *Elocution.*

THIRD TERM—*Mathematics.*—Surveying and Plotting. *Botany.*—Gray's Lessons. *Physical Geography.*—Ten Lectures on the Outlines of the Structure of the Earth. *Other studies continued. Drawing.*—Binn's Orthographic Projection.

For the Junior and Senior years the students select for themselves one of the following courses:—

(a.) In CHEMISTRY AND METALLURGY.

JUNIOR YEAR.

FIRST TERM—*Theoretical and Organic Chemistry.*—Lectures. *Chemical Analysis.*—Fresenius. Use of Blow-pipe. *Laboratory Practice.*—Qualitative Analysis. Exercises in English Composition. *German. French.*

SECOND TERM—*Laboratory Practice.*—Qualitative Analysis, continued. Quantitative Analysis, begun. *Zoölogy.*—Lectures. Exercises in English Composition. *German. French.*

THIRD TERM—*Mineralogy.*—Dana's. Lectures and Practical Exercises. *Organic Chemistry.*—Lectures. *Zoölogy.*—Lectures and Excursions. *Laboratory Practice.*—Quantitative Analysis, continued. Exercises in English Composition. *French*—continued.

SENIOR YEAR.

FIRST TERM—*Metallurgy.*—Percy's. Lectures. *Geology.*—Dana's. Lectures and Recitations. *Zoölogy.*—Lectures. *Laboratory Practice.*—Volumetric and Organic Analysis. *Determinative Mineralogy.* Exercises in English Composition. *French*—continued.

SECOND AND THIRD TERMS—*Metallurgy.*—Lectures. *Agricultural Chemistry.*—Recitations and Lectures. *Geology.*—Dana's. *Laboratory Practice.*—Mineral Analysis and Assaying. *Determinative Mineralogy. French*—continued.

(b.) IN CIVIL ENGINEERING.

JUNIOR YEAR.

FIRST TERM—*Mathematics.*—Analytical Geometry of Three Dimensions. Church's Differential Calculus. Church's Descriptive Geometry, continued. *Surveying.*—Topographical and Hydrographic. *Drawing.*—Plotting and Chart Drawing. Exercises in English Composition. *French and German.*

SECOND TERM—*Mathematics.*—Differential and Integral Calculus. *Astronomy.*—Norton's Astronomy, with practical problems. Exercises in English Composition. *French and German.*

THIRD TERM—*Mechanics.*—Peck's Elements. *Surveying.*—Topographical. Topographical sketching in the field. *Drawing.*—Binn's Second Course of Orthographic Projections. Linear Perspective. Isometrical and Topographical Drawing. Exercises in English Composition. *French.*

SENIOR YEAR.

FIRST TERM—*Field Engineering.*—Laying out curves. Location of line of Railroad, with calculations of excavation and embankment. Henck's Field Book for Railroad Engineers. *Stone Cutting*—with graphical problems. *Mechanics.*—Mechanics applied to Engineering. *Geology.*—Dana's. *Drawing.*—Architectural. Exercises in English Composition. *French.*

SECOND TERM—*Civil Engineering.*—Mahan's. Building Materials (Lectures). Strength of Materials. Bridge Construction. *Surveying*—with Plane Table. Geodesy. *Drawing.*—Mechanical. *French.*

THIRD TERM—*Civil Engineering.*—Bridge Construction, continued. Stability of Arches and Walls. *Dynamics.*—Principles of Mechanism. Steam Engine. *Hydraulics.*—Theory of Turbines and other Water Wheels. D'Aubuisson's Hydraulics. *Drawing.*—Structural.

Students pursuing a higher course in Engineering, for one year after graduating as Bachelors, may receive the degree of Civil Engineer.

(c.) IN DYNAMIC ENGINEERING.

JUNIOR YEAR.

Pure and Applied Mathematics.—Geometry of Machinery. Analytical Geometry of Three Dimensions. Differential and Integral Calculus. *Mechanics.*—Analytical Mechanics. *Drawing.*—Binn's Orthographic Projections. Principles of Construction. Shading and Tinting, and drawing from Patterns. *Metallurgy.* Exercises in English Composition. *French and German.*

SENIOR YEAR.

Applied Mechanics.—Strength of Materials. Theory of Machines. Theory and Construction of the Steam Engine and other prime movers. Mill work. Examination of Machinery. Mechanical Construction. Use of tools. *Drawing.*—Drawing from actual Machines. Designs of Machines. Exercises in English Composition. *French. Metallurgy.*

(d.) IN AGRICULTURE.

JUNIOR YEAR.

FIRST TERM—*Theoretical and Organic Chemistry*—Lectures. *Experimental and Analytical Chemistry*—in their Agricultural applications. Laboratory practice. *French*—begun. *German*—continued.

SECOND TERM—*Agricultural Chemistry.*—Recitations. *Experimental Chemistry.*—Laboratory practice. *French and German*—continued. *Physical Geography.*—Lectures. *Zoölogy.*—Lectures.

THIRD TERM—*Agricultural Chemistry.*—Lectures. *Horticulture and Kitchen Gardening.*—Lectures. *Mineralogy.*—Lectures and Practical Exercises. *Zoölogy.*—Lectures. *Experimental Chemistry.*—Laboratory practice. *French*—continued. *Drawing.*—Free-hand practice. *Excursions.*—Botanical, Zoölogical, etc.

SENIOR YEAR.

FIRST TERM—*Agriculture.*—Cultivation of the Staple Crops of the Northern States. Lectures. *Agricultural Zoölogy.*—Origin and Natural History of Domestic Animals. Insects useful and injurious to Vegetation. Lectures. *Geology.*—Dana's. *French*—continued. *Excursions.*—Agricultural, Zoölogical, Geological, etc.

SECOND TERM—*Agriculture.*—Stock-raising and principles of Breeding. Lectures. *English. Human Anatomy and Physiology.*—Lectures. *French*—continued.

THIRD TERM—*Rural Economy.*—History of Agriculture and Sketches of Husbandry in Foreign Countries. Adaptation of farming to soil, climate, market, and other conditions. Systems of Husbandry. Stock, sheep, grain, and mixed farming. Lectures. *Excursions.*—Agricultural, Geological, Zoölogical, and Botanical.

(e.) IN NATURAL HISTORY.

(Either Geology, Mineralogy, Zoölogy, or Botany may be made the principal study, some attention in each case being directed to the other three branches of Natural History.)

JUNIOR YEAR.

FIRST TERM—*Zoölogy.*—Daily Laboratory instruction; Zoölogical Excursions. *Botany.*—Gray's Text-Book; Use of the Microscope. *Chemistry.*—Theoretical and Organic Chemistry. *French*—begun. *German*—continued.

SECOND TERM—*Zoölogy and Palæontology.*—Laboratory practice. Lectures. *Botany.*—Lectures; Gray's Text-Book. *Physical Geography.*—Lectures and Recitations. *Chemistry.*—Laboratory practice. *French and German*—continued.

THIRD TERM—*Zoölogy and Palæontology.*—Laboratory practice. Lectures, Excursions (land and marine). *Botany.*—Excursions. Practical exercises. Gray's Manual. *Mineralogy.*—Dana's. Lectures. Practical exercises. *French*—continued. *Drawing.*—Free-hand practice.

SENIOR YEAR.

FIRST TERM—*Language.*—Whitney's Language and the Study of Language. *French.*—Selections. *Zoölogy and Palæontology.*—Laboratory Practice. Lectures. Excursions. *Botany.*—Excursions. Herbarium studies. *Geology.*—Dana's Manual. Excursions.

SECOND TERM.—*Zoölogy and Palæontology*—continued. *Botany.*—Herbarium studies. Botanical Literature. Essays in Descriptive Botany. *Geology.*—Dana's. *Anatomy and Physiology.*—Academical Lectures. *French.*—Selections. *Whitney on Language*—continued.

THIRD TERM.—*Zoölogy, Botany, and Palæontology*—continued, with Excursions. *Photography.*—Practical instruction.

Besides the regular courses of lectures on structural and systematic Zoölogy and Botany, and on special subjects, students are taught to prepare, arrange, and identify collections, to make dissections, to pursue original investigations, and to describe Genera and Species in the language of science. For these purposes, large collections in Zoölogy and Palæontology belonging to the College are available, as are also the private botanical collections of Professor Eaton.

(f.) IN PREPARATION FOR MEDICAL STUDIES.

During the Junior year, the work of this course will be chiefly under the direction of the instructors in Chemistry. Especial attention will be given to qualitative and quantitative analysis, in their physiological and medical bearings; and to

the preparation and study of the organic proximate elements. In the Senior year, the work will be chiefly under the direction of the Professors of Zoölogy and Botany. Attention will be paid in Zoölogy to comparative anatomy, reproduction, embryology, the laws of hereditary descent, and human parasites; and in Botany to a general knowledge of structural and physiological Botany, and to medicinal, food-producing, and poisonous plants. The studies of the Select Course in Physical Geography, History, English Literature, etc., are followed by these students.

(g.) IN STUDIES PREPARATORY TO MINING.

Young men desiring to become Mining Engineers, can pursue the regular course in Civil or Mechanical Engineering, and at its close can spend an additional year in the study of metallurgy, mineralogy, etc.

(h.) IN SELECT STUDIES PREPARATORY TO OTHER HIGHER PURSUITS, TO BUSINESS, ETC.

JUNIOR YEAR.

FIRST TERM.—*German, Anglo-Saxon and Early English, and Drawing*—continued. *French*—begun. Lectures and Exercises in Chemistry and Mineralogy. Physical Geography.

SECOND TERM.—*German, French*—continued. *English.*—Chaucer. *Astronomy.*—Norton's Astronomy, with practical problems. *Modern History.*—Recitations and Lectures.

THIRD TERM.—*French*—continued. *English.*—Shakespeare. *Mechanics.*—Peck's Elements. *Botany and Zoölogy.*—Lectures and Excursions.

SENIOR YEAR.

LANGUAGE.—The study of French is continued through the year, and during the first two terms there are recitations in Whitney's Language and the Study of Language. In English, Shakespeare, Milton, Dryden, and Pope are the authors studied throughout the year, and in the order here named.

NATURAL SCIENCE.—The study of Geology is pursued by recitations, lectures and excursions. Lectures are given in Rural Economy and the Principles of Agriculture, and also in Agricultural Chemistry. Botany is studied during the early part of the autumn term.

HISTORY, GEOGRAPHY, AND POLITICAL ECONOMY.—Lectures, Recitations, and Exercises will be continued through the year.

Exercises in English Composition are required during the entire course from all the students. During the Senior year, the preparation of the thesis occupies the attention of the class.

Lectures on Military Science and Tactics are annually given.

VI.

LECTURES.

The instructions of this institution are given chiefly in small class rooms, by recitations or familiar lectures, illustrated by the apparatus at the command of the various teachers. A public course of lectures is given every winter on topics of popular interest. On Sunday evenings, during a portion of the year, lectures are given by resident clergymen of different denominations, and by members of the Scientific and other college faculties.

VII.

TUITION CHARGES.

The charge for tuition is $150 per year, payable $55 at the beginning of the first and of the second term, and $40 at the beginning of the third term. The special student of Chemistry has an additional charge of seventy-five dollars per annum for chemicals and use of apparatus. He also supplies himself at his own expense with gas, flasks, crucibles, etc., the cost of which should not exceed ten dollars per term. An additional charge of five dollars is annually made to each student for the use of the College Reading Room and Gymnasium.

VIII.

CHURCH SITTINGS.

Free sittings for students in this department of Yale College are provided as follows:

In the Center Church (Cong.), Rev. G. L. WALKER, D.D.: Pews No. 36 and 42, in the North Gallery.

In Trinity Church (Episc.), Rev. E. HARWOOD, D.D.: Pews No. 175 and 177, in the North Gallery.

In the First Methodist Church, Rev. G. W. WOODRUFF, D.D.: Pew No. 78, at the head of the West Aisle (below).

Any of the students may occupy a sitting in these slips. Those who prefer to pay for a sitting for a year, more or less, in the churches above mentioned, or in any other church of any denomination, will be aided on application to the Secretary of the School.

Sittings in the Gallery of the College Chapel are free as heretofore to the students of this department.

IX.

Degrees.

Students of this department, on the recommendation of the Governing Board, are admitted by the Corporation of Yale College to the following degrees. They are thus conferred:

1. Bachelor of Philosophy: on those who complete any of the three-year courses of study, passing all the examinations in a satisfactory manner, and presenting a graduation thesis.

The fee for graduation as Bachelor of Philosophy, including the fee for Triennial Catalogues, Commencement Dinners, etc., is ten dollars; unless the person taking the degree is also an academical graduate, when it is but five dollars.

2. Civil Engineer and Dynamic Engineer: The requirements for this degree are stated on page 17.

3. Doctor of Philosophy: The requirements for this degree are stated on page 16.

X.

Terms and Vacations.

The next academic year begins Thursday, September 11, 1873. Examinations for admission Saturday, June 21, Friday, June 27, and Wednesday, Sept. 10. The vacations correspond with those of the Academical Department, giving two weeks at Christmas, two weeks in the Spring, and ten weeks in the Summer.

XI.

Explanation of some of the Studies.

In explanation of some of the studies which are pursued by the Select Course students, and are more or less attended by the students of other courses, the following statements are given. Post-graduate students may, at their option, attend the exercises here referred to, when the hours do not interfere with their other specialties.

Botany.

The study of Botany begins in the summer of Freshman year, with recitations from Gray's Lessons on Structural and Physiological Botany, illustrated by examples from nature.

In the summer of Junior year, exercises in analyzing and identifying plants occur two or three times a week, followed by practice in writing characters and descriptions of plants from living

specimens. Students are shown also how to collect and preserve specimens for future use, several Natural Orders being especially indicated to each class for special work in collecting. Excursions every Wednesday.

In the autumn term of Senior year, the work of the summer is continued. Students will now begin to write generic as well as specific characters, and at the close of the term an essay on some one Natural Order will be required. During the second and third terms, a Herbarium of the indicated Natural Orders will be prepared and presented for examination at the end of the year.

In the same terms a course of lectures on Botany is given to the Senior Class of the Academical Department, and the Seniors of the Select Course are expected to attend these lectures.

Zoölogy.

The instruction in Zoölogy consists of the following courses:

a. In the second term of the Junior year, a course of lectures on Comparative Anatomy and Physiology, and the Principles of Zoölogy. The students are required to take notes, and are questioned at the beginning of each lecture upon subjects of the previous one.

b. During the third term of the Junior year, a course of lectures upon systematic Zoölogy, including the structure, classification, metamorphoses, and habits of animals. This course is intended partly as a preparation for Geology.

c. Weekly excursions during the third term of Junior and first term of Senior year, in company with the instructors, for the purpose of observing the habits and making collections of marine, fresh-water, and terrestrial animals of all classes. Each student is required to prepare and present for examination a collection containing a specified number of species, and illustrating the various classes of animals. He must also be able to pass an examination upon his collection, at least to the extent of explaining the classes illustrated, and showing why particular specimens belong to their respective classes.

d. During the first term of the Senior year, lectures on various special subjects, such as Domestic Animals, the Laws of Reproduction and Breeding, Embryology, Theories of Evolution, Geographical Distribution, and Applied Entomology.

Geology.

The instruction in Geology is as follows:

a. During the first and second terms of the Senior year, recitations three times a week in Dana's Manual, illustrated by numerous specimens of minerals, rocks and fossils, and also diagrams and charts.

b. Excursions into the country in the first term to examine Geological phenomena, and to see the rocks in place.

c. Frequent visits to the Geological collections in company with the instructor, for the purpose of seeing larger series of fossils than can be exhibited in the class room.

Physical Geography.

In the third term of Freshman year, a course of ten or twelve lectures, with questions and drill upon the maps, will be given, as an introduction to Physical Geography and a review of elementary studies. These exercises will chiefly relate to the globe in its entirety, and to the separate continents.

In the Junior year, the study of a text-book will be followed with illustrative lectures, and practical lessons upon the globe.

In the Senior year, the careful study of the continents of Europe and North America will be taken up, chiefly with reference to their physical peculiarities, but with an incidental regard to national progress.

XII.

LATIN.

The requirement of a certain amount of Latin as preparation for entrance into the Sheffield Scientific School causes so many inquiries that a few words of explanation of its nature and purpose seem called for.

First, as regards its reason. This is partly the intrinsic value of the Latin itself, partly its value as a preparation for other studies pursued in the School. That its acquisition is of great practical importance to educated men in every department is obvious. Were it only that almost all scientific nomenclature and phraseology is founded upon it, this would be reason enough for its inclusion among the studies of scientific men. An additional reason is that so much of our ordinary English speech is also of Latin origin. A man can no more claim to have enjoyed a fairly

liberal education—an education that shows him the foundation and relations of things, and gives him command of useful instruments for further knowledge—without Latin than without German or French.

The language studies pursued in the School are mainly German and French. As things are at present in the preparatory schools, we are obliged to commence work upon those two languages with the very rudiments. But we need something that shall give our pupils a degree of practice and facility in taking hold of a strange language, in order to bring them to those others with a certain preparation, and enable them to make more rapid and equal progress. Nothing in this way is so useful as a little thorough training in the Latin Grammar and in Latin translation. Moreover, this training is more universally and readily accessible than any other. The text-books are all that could be desired, and every good school, and almost every community furnishes teachers who are qualified to help the beginner. And even if such helps were wanting, no capable and energetic young man need be afraid to take up a Latin grammar, and master by himself enough of it to begin reading.

As to the amount, we do not venture yet to require much—only the essential parts of the grammar, and ability to read and construe with intelligence some Latin author, such as Cæsar, or Virgil, or Sallust, or Cicero; this can be learned without difficulty by making the study one of those pursued through the year before entering.

XIII.

Announcement in Respect to State Students.

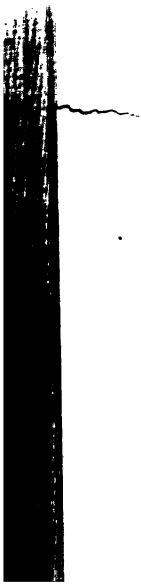
The scholarships established in this School in consequence of the bestowal upon it of the Congressional grants are designed to aid young men who are in need of pecuniary assistance in fitting themselves for agricultural and mechanical pursuits of life. All applicants must be citizens of Connecticut. In case there are more applicants than vacancies, candidates will be preferred who have lost a parent in the military or naval service of the United States, and next to these such as are most in need of pecuniary assistance; and the appointments will be distributed as far as practicable among the several counties in proportion to their population. The Appointing Board for the current year, consisting of the Board of Visitors of the State and the Secretary of the School, will meet on

June 23, 1873, and at about the same time in the year 1874, due notice of which will be given by publication in every county of the State. All applications should be made previous to that time. Blank forms for application will be sent, when requested, by Professor GEORGE J. BRUSH, Secretary of the Appointing Board.

XIV.

ANNIVERSARY.

The Annual Meeting of the State Board of Visitors occurs in the second term, this year on Thursday, March 20th. The Anniversary of the School is held on Monday of the Commencement week in Yale College, June 23, 1873, when selections from the graduation theses are publicly read. The degrees are publicly conferred by the President and Fellows of Yale College on Commencement Day.



NINTH

ANNUAL REPORT

OF THE

SHEFFIELD SCIENTIFIC SCHOOL

OF

YALE COLLEGE.

1873–74.

PRINTED BY ORDER OF THE GENERAL ASSEMBLY.

NEW HAVEN:
TUTTLE, MOREHOUSE & TAYLOR, PRINTERS.
1874.

REPORT OF THE STATE BOARD OF VISITORS.

To the General Assembly of the State of Connecticut:

THE State Board of Visitors of the Sheffield Scientific School respectfully report that they have visited that institution during the past year, as required by their duties.

They have found the School in a high state of efficiency, its number of scholars never larger, its corps of able instructors zealous and faithful, and fully determined to keep it the leading school of science in the country, a position which it is now generally conceded to hold.

But its condition is so fully set forth in the accompanying report of the Governing Board, that a detailed statement of its affairs here would be superfluous. It is fully carrying out the noble design of its founders and benefactors, and contributes in large measure to the intellectual culture of our State.

In behalf of the Board,

CHARLES R. INGERSOLL,
Chairman.

BIRDSEY G. NORTHROP,
Secretary of the State Board of Education.

NEW HAVEN, May, 1874.

ANNUAL STATEMENT

OF THE

GOVERNING BOARD.

In presenting their Ninth Annual Report the Governing Board are again enabled to bear witness to the increasing prosperity of the Sheffield Scientific School, and to express their gratification at the appreciation and favor which it still continues to receive from the public. While the past year has not been marked by any eventful changes, much of the interior working of the school has undergone thorough and careful revision. The increased accommodations presented by the new building not only enabled the Governing Board to carry on, for the first time in many years, the instruction entirely upon their own ground, but to furnish facilities for study and investigation which could not previously be afforded. In particular, the course in drawing has now been organized on a scale commensurate with its great importance; the laboratories for the study of chemistry and determinative mineralogy have been nearly doubled in size; and an entire reorganization of one of the special courses has been made and will go into effect during the coming year. A description of the changes which have been effected and the events which have taken place will be given in detail, beginning with the formal opening of the new building.

Opening of North Sheffield Hall.

The new building, a description of which can be found in the last Annual Statement, was formally opened on the afternoon of Wednesday, June 4, 1873. The General Assembly of the State, then sitting at Hartford, adjourned for the purpose of attending the exercises. At three o'clock the invited guests, consisting of the State officers, the members of both branches of the Legislature, the members of the Corporation and of the various faculties of Yale College, and numerous citizens, friends of the school, assembled in the lecture room of the new building. The platform

was occupied by President Porter, ex-President Woolsey, Governor Ingersoll, ex-Governor Jewell, minister to Russia, ex-Governor Hawley, ex-Governor Buckingham, and Professor Brush. An abstract of the speeches delivered upon the occasion is here given. Professor Brush, as executive officer of the School, made, in behalf of the Governing Board, the formal address of welcome to those present, and in behalf of Mr. SHEFFIELD the formal presentation of the building to President Porter as the representative of the University, as follows:

The Governing Board of the Sheffield Scientific School feel honored to welcome his Excellency, the Chief Magistrate of the State, and other State officers, the members of the General Assembly, the President and Fellows of Yale College, and the several faculties of the University, together with other friends from far and near, to enjoy with them the opening of a new building—the gift of our munificent patron, Mr. JOSEPH E. SHEFFIELD.

The growth of the Scientific School in the number of students, and the increase of apparatus and collections, made it necessary, three years ago, to colonize the department of Mechanical Engineering, and through the courtesy of the director of the Yale School of the Fine Arts, Prof. Weir, we were generously accorded quarters for this purpose in the basement of the Street Art Building. The Laboratory of Zoölogy was likewise located off our grounds in the basement of the old Trumbull Gallery, and Botany had no foothold except in the professor's private residence. At this time we were sorely pressed for means to keep together our band of instructors, and, although our faith never wavered in regard to the ultimate success of the school, we did not dare give expression to the fears we then entertained that the growth of the institution in the immediate future would require accommodations which we should be unable to furnish.

Very soon, almost coincident with this, however, our generous friend, appreciating the situation, without a suggestion save the promptings of his own noble heart, quietly, as is his wont, informed us that he had deeded to the school the lot of land where this building now stands, and that it was his purpose at an early day to erect thereon a suitable building.

Mr. Sheffield gave no instructions in regard to the building, other than that it should be well adapted for the use of the institution. A committee was appointed, and to it he entrusted the character of the design, the making of the contracts, and the entire furnishing and fitting up of the interior of the building. The members of the committee have given the building their constant attention, and they believe that you will all recognize how greatly they have been indebted to the skill and taste of the architect, Mr. Cady of New York, and to the conscientious fidelity of the contractors, Messrs. Perkins & Chatfield, and Mr. Charles Thomp-

son, of this city, in every detail of construction. We consider ourselves very fortunate in having had such disinterested men associated with us.

The building contains this lecture room and four recitation rooms on the first floor; two large rooms, temporarily used as drawing rooms, in the basement; a lecture room and laboratory for Physics, and drawing, model and recitation rooms for Civil Engineering, on the second floor; a laboratory for Zoölogy and also another for Botany, and drawing, model and recitation rooms for Mechanical Engineering, and private studies for professors, on the third floor; and in the attic, or fourth story, a large drawing room for the Freshman class, and dormitories for assistants.

With this brief statement of facts, I now, sir, as the representative of the Building Committee, and through them of Mr. Sheffield, tender to you, the President of our University, the use of this land and building for the purposes of the Sheffield Scientific School, and, representing the Governing Board, I ask that this building may be known as NORTH SHEFFIELD HALL.

The gift of the building was acknowledged by President Porter in a speech, of which the following summary is given:

Next to the blessing of giving is the satisfaction of receiving. It is with great satisfaction that I acknowledge, in the name of the college, the generous gift of Mr. Sheffield. I will not speak of its many excellencies, for it has spoken for itself to all who have seen it. I think I can safely say that it is without a rival in the country. Much honor is due to the architect, much to the committee, and much to the builders, who have conscientiously and faithfully performed their parts. There is wrought in this building more than is seen. It stands as a testimonial of the value of the school itself, since it shows in every part what science can do for the convenience of man. It is valuable also for the sake of the giver. We are pleased to receive benefits which show that those who have passed away have thought for the welfare of those who were to come after them. We are doubly pleased when we take gifts warm from the hand of the living giver, especially when, as in this case, it crowns a long series of benefactions. I regret that his sensitive modesty has kept him away from this gathering, so that he cannot see how deeply we appreciate his generosity. It has been given to many to aid institutions of learning, but it has been given to none to meet the opportunity so generously, so modestly, and so perseveringly. The President then spoke of the wonderful growth of the school, from the time when it was struggling for existence in its old wooden house on the college green, following it up through its course until Mr. Sheffield became connected with it, and met its successive wants. He honored the noble man who had been spared to see this day. It was not for any want of interest in these exercises that he was absent. *The President* then referred to the presence of a great portion of

the Legislature. He was glad that they were present to see the good fruits of their help for the past ten years. He thought that the State had received as much as it had given. He was glad to be able, in the presence of the faculties of the university, to express in their name the fraternal feeling and kindly interest which was felt by each and all for every department. There is no jealousy between the old and the new educations. The old has much to learn from the new, and I do not doubt that the new will take from the old that which it has to give. I am delighted that the realism of science and of practical life has been brought into connection with the memories of history. In the presence of all these faculties, I hail and rejoice in the prosperity of the school.

At the conclusion of his address, President Porter called upon Governor Ingersoll. The Governor said:

Mr. President—It is particularly pleasant for me that I appear here not only as an inhabitant of the State of Connecticut, but also as a townsman and a graduate of the institution with which you are connected. To-day marks an epoch in the life of the school. You are right in saying that there is no jealousy between the old and the new. This benefaction is but a repetition of the benefaction of that other great merchant who founded Yale College. But in the seventeenth century through a study of the dead languages lay the only path to knowledge. Learned men then lived for the most part in the clouds. But in course of time the fire was brought from the heavens down to the earth, and now any one who thoroughly understands his own tongue is able to master nearly every branch of knowledge. From this institution the State has derived especial advantage. We used to hear much about the pauper labor of Europe and the impossibility of competing with it. We do not hear this now, for it is widely known that it is not pauper labor we have to fear, but skilled labor—the work of the brain. This change in general feeling must be attended with great material advantage to the State, and it has been produced by the influence of this institution and institutions like this. I have already detained you too long, but I must not stop without a word of tribute to the man to whose munificence and foresight we owe this building. We know of him, as fellow townsmen, in a way I hardly dare to trust the dictates of my heart to speak of. We remember how he came to this city as a retired man of business. Since that time his life has been marked, not by years, but by great and splendid gifts to this city, and for these, and in connection with these, his name will live as long as history.

At the conclusion of Governor Ingersoll's address, President Porter remarked that in 1846 Dr. Woolsey was chosen President of Yale College, and at the same time the department of Philosophy and the Arts was organized with two professorships; and out

of this small beginning had grown the Sheffield Scientific School. He called upon Dr. Woolsey, who spoke as follows:

If testimony and recollection of what took place from the beginning is required, then I am, perhaps, the fittest person to speak of these things, for I was present, so to speak, at the birth of this school. But after what has been said I do not think it necessary to add any testimony in regard to the school in its struggling infancy. But there is another point in regard to which I wish to give emphatic testimony. I have been thoroughly acquainted with the energetic efforts of the professors for its advancement. From the first they have struggled against probabilities. They have worked by faith. They have aimed to have a school, sink or swim, worthy of the science of this country. During all these twenty-six or twenty-seven years their constant aim has been to raise the standard of admission, to increase the excellence of the course of instruction, to raise the standard of the examinations for degrees, and in fact to raise the standard of the school in every particular. As a result, I think that there is, confessedly, no other school of this character, in this country, which is on a level with this. Two elements are necessary to the constitution of any public place of learning—the spiritual and the corporeal. By the latter I mean the places of instruction, the apparatus, the books, and all that is necessary for conveying instruction to the student. In early times the corporeal was of little value on account of the prevalence of the simple lecturing system, as at Bologna. Professors had lecture rooms at their own houses, and gave lectures and took fees. Now, what can we do without books, apparatus and other conveniences for helping the understanding of the student? But notwithstanding the importance of conveniences, the great thing is the spirit—the ability, energy and self-sacrificing devotion to science of the professors. I have watched the efforts of the professors to make this school worthy of the country and the nineteenth century, and I would give equal honor to their devotion and to the munificence of the giver.

At the conclusion of Dr. Woolsey's address, President Porter said the audience had often enjoyed Governor Jewell's finished use of the English language, and in consideration of the fact that he was soon going where he would not have much chance to use his mother tongue, he called upon him to take advantage of this opportunity. Governor Jewell said:

I think that I and other outsiders appreciate more fully the value of this institution than do those who have graduated from it; and the proof of this lies in the fact that many of the most munificent gifts to the college have come from those who did not in youth enjoy its benefits. Coming, as I do, directly in contact with labor, I see that the great problem of labor and

capital must be solved by increasing the productive power of the latter; and it is by the agency of institutions like this that this productive power is most rapidly and surely developed. It gives me pleasure to bear witness also to the spirit which the managers of this school have invariably exhibited ever since I have been acquainted with it. It was to me at first a novelty and surprise. I well recollect the first time I met with my associates as a member of the Yale corporation. I had been in many corporations, and was thoroughly acquainted with them and the nature of their proceedings. But those were business corporations, and at their meetings I had been accustomed to many applications for increase of salary. In fact, such applications were the most common thing in the world. But now I was in a different atmosphere. I was astonished at that meeting to see eight or ten applications from professors of this school praying, not that their salaries—little enough at best—might be increased, but that they might be decreased, in order that the money thus saved might be employed to render more efficient the instruction here given. I thought the good time coming of which we have so often heard was the good time come; and I saw in that one act of devotion and self-sacrifice the proof of that spirit which has placed this institution at the head of the Scientific schools of this country, and which I feel confident will continue to keep it in that position.

At the conclusion of Minister Jewell's address, the President introduced ex-Governor Joseph R. Hawley, who said:

I am only repeating what is always said on such an occasion, when I say I am glad to be here. But it is true; and the great reason why I rejoice is that I see that rich men are beginning to find out what to do with their money. If any man will take a look at my friend General Walker's statistics, showing plainly the prevalence of ignorance in the country, he will see the need of education. If he then looks to see what has been done, he finds that the two greatest institutions of learning, Yale and Harvard, worth perhaps $3,000,000 each, have been struggling along for years, and keeping alive only through the efforts of the self-sacrificing men who compose their faculties. He then takes a look at the New York Central Railroad with its capital of $100,000,000. How much would the cost of a single man-of-war benefit one of these institutions, and have an influence forever, while the ship would soon rot away? He looks around on manufacturing enterprises, and finds that one of these, confined to a few small buildings, has a capital exceeding the capital of Yale. He sees a lamentable under-estimation of some things and over-estimation of others. What then ought Yale to have? What it needs, if it be $10,000,000 or $20,000,000. Many persons could give this amount and not feel it—yes, they would feel it, they would feel better, here and hereafter. This university never should want for any-

thing. It should be entirely beyond interference from without and fear of any kind. Seven years ago I was present at a little meeting in the library, when great fear was expressed lest the school should lose some of its best men. The question was, shall the school go on, try to get money, and live, or shall it die? I listened, and at the close of the meeting I told them I knew they would succeed, on account of a beautiful fanaticism which I saw there—a mutual pledging, a determination to get money somehow. And those men, aided by Mr. Sheffield, have placed the school where it is. It is the best school of its kind in the country, and I say this on the testimony of men of science who know. If it is not, it must be made the best. If there are others better, the country is to be congratulated. I am glad there is no clash between the old and the new. There is room for both. I have just been reading a work by Matthew Arnold. I had heard before of his "sweetness and light," but I find his sweetness very sour. [General Hawley then read certain passages relating to this country.] He belongs to that class of persons who think it the *summum bonum* of existence to lie in the sunshine and suck sugar. He would cultivate his intellectual finger nails until they ran into the ground. I believe that the men who *do* something have a moral sweetness and light superior to this. Man was not made to sit in a closet, as Mr. Arnold would have him, and make himself beautiful. He is only a unit of the great whole, which it is his business to better.

The President then called upon Senator Buckingham, who spoke as follows:

When I have turned my attention to your honored citizen, the testimony of whose liberality we see here to-day, I have rejoiced at his prosperity and have been glad that he has known so well how to use his money. The value of a knowledge of science is felt in every department of life. The physician cannot get along without a knowledge of chemistry. The lawyer must know something of mechanics in order to defend his clients' inventions. My own ignorance of chemistry caused me to lose more in the dye house, during eighteen years in which I was manufacturing carpets, than I made in all the rest of the establishment. I would say for the benefit of Professor Brewer that I believe the time will soon come when the farmer will raise more on ten acres than the majority of them do now on one hundred. These are the benefits we reap. Dr. Woolsey will live to see more young men coming to this department than to the academic. These young men are to be our public men of the future. This institution is to control the business and make the laws of this commonwealth. Do you wonder that, with this belief, I am envious? There is a remedy for this envy, however. It is this—give money, voice and all your energies for the support of the school.

Charlton M. Lewis of New York being called upon, responded as follows:

It is fitting, perhaps, that I should be called upon at this particular time, for the progress of the speeches has been from the abstract to the practical. Some months ago I met in New York one of those moneyed men of whom General Hawley has spoken, able to give an amount of money equal to the value of Yale's property, and not feel it. I talked with him about the Scientific School and its wants, and what a magnificent future was in store for him who was so fortunate as to give largely to it. He said he had often thought of this, and in the course of our conversation he unbosomed himself to me so that I thoroughly understood him. He labored under a sense of responsibility, in regard to his wealth, which was oppressive. He really deemed it his paramount duty to increase the rate of interest at which his fortune has been accumulated. Now this is the age of the study of political economy, and when men feel as this one did we must subject the school to the general test. We must prove to them that money put here is better invested than anywhere else. What was the best investment made in the first century? I think we shall all agree that it was the money spent on St. Paul's education. And so with Luther and Lord Bacon. So can be said in future of the graduates of this school, if, as no one doubts, skilled labor is worth more than that which is unskilled. Science has a wonderful influence. No man can tell how much difference it will make in the future to take now one man out of the ranks of ignorant labor, and by training place him among the thoughtful, who are the leaders. This money of Mr. Sheffield's is doing more than the money invested by capitalists in means of communication and like enterprises. And if this is true now, how much more so will it become in the future.

At the conclusion of the addresses, the audience were invited to pass through and inspect the building; after which a collation was served up in the drawing-room in the fourth story. With this the exercises of the day ended.

Extension of the Course in Drawing.

Although drawing has to a greater or less extent been made a part of the system of instruction given in the school from the foundation of the Engineering section, it has been long felt by the Governing Board that more systematic and prolonged training should be imparted in this branch than has been actually the case. For a person whose occupation rarely demands even a rough sketch of the simplest forms, a mere knowledge of the elements of this art, with a small amount of practice, may suffice. But when

drawing constitutes, as it does now in many scientific professions, the principal means of expressing ideas and imparting knowledge, thoroughness of training in this branch of instruction becomes of the first importance. It was evident that the methods employed in the institutions in this country had thus far failed to develop the same degree of excellence that is to be found in young men who come to us from abroad. Our manufacturing establishments, our public works, and offices, have found it to their advantage to employ for the positions requiring most skill in drawing, young men who had been trained in European schools. The deficiency evidently did not lie in our students; on the contrary, there is no branch of learning which they enter upon with more eagerness or pursue with more earnestness. It was felt that the defect must lie in the course of instruction adopted, and in the want of thoroughness in carrying it out; and in one particular the erroneousness of the methods commonly pursued was conspicuously manifest. The geometrical basis of the art, Descriptive Geometry, is commonly taught as an abstract science at the blackboard, or by simply requiring the drawing of the problems by means of drawing instruments; and after a few lessons from models, the student is perhaps allowed to copy, at will, complete drawings, or to attempt the more difficult process of composing a structure of which he does not understand the principles, and has not the requisite knowledge for adjusting the proportions and parts. As he speedily finds that he is beyond his depth, and that he has not the power of executing properly what he has designed, he naturally becomes dissatisfied. The only resource left him is to make pictures; and he bestows his greatest care on the fineness of the lines and the delicacy of shading. He does not acquire the power of delineating readily the internal as well as external parts of a structure by projecting them orthographically upon any plane, by the representation of lines of penetration, or the elements of surfaces. If these are known at all, they are only known theoretically, and he finds when his course is completed, and he is brought into contact with the practical problems of his profession, that the instruction he has received has been of little benefit.

The importance of putting this course upon a more satisfactory basis has for some time been made more and more apparent to the Governing Board; and the facilities furnished by the new building gave them the opportunity to carry into effect the

that were entertained. A committee was appointed to consider the whole subject, and the course of instruction which it recommended met the approval of the entire body, and went immediately into effect. This course is intended not only to furnish the ground-work of principles drawn from descriptive geometry and the conventional symbols of representation, but to lead the student by successive steps through the whole range of the application of these principles. At each step such an amount of actual practice is required as to impress the knowledge gained of the principles permanently upon the mind. The course for one year is obligatory upon all students; for those purposing to devote themselves to Engineering or Architecture it extends through three years, and is divided up in the following manner. The first half year is devoted exclusively to

Free-hand Drawing,

this being placed at the beginning for the purpose of familiarizing the student with the use of the pencil, and by this means preparing him for the ever-recurring demands which his subsequent instruction makes upon this use; but more especially for the sake of training the eye and understanding to see correctly without mechanical aids. This course is carried on at the Yale School of the Fine Arts, and is under the direction of Professor J. H. Niemeyer of that department. It begins at once with the human figure, which has been simplified and reduced to geometrical bases; that is, the human figure, or any part of it, is embraced within the limits of right lines and angles. A student, therefore, in drawing, for instance, the profile view of a head, constructs the general proportions by bounding the forehead, nose, lips, chin, and other points, with straight lines. To do this he necessarily judges of the direction and length of one line and places it accurately upon the paper; he then observes the angle that another line forms with it, and so goes on, until he has constructed the whole figure. These right lines are then given a more definite expression by drawing other lines through them, to determine the character of the form represented. Well-directed training and close application will soon develop in the student the power to judge of form and proportion with accuracy, and to represent them with precision. The human figure has been adapted to this exercise, because in it, to the abstract idea of a right line, may be added the interest which character and expression give, and also because disproportions are more easily discovered in this than in

any other object in visible nature. This course is obligatory upon all students, and is completed by the middle of the second term. It is immediately followed by the course in instrumental drawing.

The general nature of the course in

Instrumental Drawing

may be briefly stated, as follows. It begins with the elements of Descriptive Geometry practically applied to the projections of plane surfaces. No models are employed, and every student is obliged to go through precisely the same course, the practical problems being varied so much as to prevent any mere copying by one from another. Binns' Course of Orthographic Projections is adopted as the basis of instruction, though no actual study of the book is required. The Elementary Course, which follows directly upon the course in free-hand drawing, includes all difficult projections of points on vertical and horizontal planes, the projection of sections, the projection of the lines of penetration of solids, and generally the power of dissecting a solid and representing all lines and surfaces, whether concealed or visible, by the proper geometrical methods of construction, combined with the established conventional features of the art, upon planes of projection. In this it is rarely necessary to give assistance to the imagination by means of models, and it is never desirable if it can be avoided. This elementary course embraces twenty-three plates or sheets, each sheet constituting the exposition of some principle or process, with numerous variations or modifications Descriptive Geometry as an abstract study does not precede the Elementary Course, but is introduced after the student has become familiar with the practical methods of working, and is able to draw accurately, and without mere copying, the necessary figures. Indeed, the Elementary Course of Binns' Orthographic Projections and the first problems of Descriptive Geometry are in reality practical and theoretical expositions of the same general ideas, and should therefore be closely connected by being embraced in the same scheme and taught by the same instructor or instructors. In a corresponding manner the more difficult problems of Descriptive Geometry, including warped surfaces, are brought into the second year's course.

The twenty-three plates comprising the Elementary Course, but not including the problems of Descriptive Geometry, are divided as follows:

The first nine sheets relate to the projections on horizontal and vertical planes, of points, right lines, surfaces bounded by right lines, solids bounded by plane polygons, and the intersection of such solids by planes. The exercises begin with the more simple forms, and extend to the most complex solids with internal cavities or hollow spaces.

Four sheets are devoted to the projections of curved lines, including the intersection of curved surfaces.

Five sheets are devoted to the projections of the lines of penetration of solids; two sheets to the development of surfaces; and three sheets to Isometric drawing. In this last a model is introduced to test the progress that has been made.

Each student is required to follow strictly the prescribed course, the problems being varied for different individuals only in the positions of the planes or form of curve. The course extends through the second half of the first year, and is obligatory upon all.

For the second year an additional course in continuation of the first is provided for those who intend to pursue the profession of Civil or of Dynamic Engineering, or of Architecture, and is obligatory only upon these. This course embraces eighteen plates or sheets, one of which is devoted to the construction, by projection, of screws, springs, and nuts; three to propeller blades; two to spur-gearing; three to bevel gearing; one to the construction of various helical and cycloidal curves; two to teeth of wheels; one to cams; and five to projection of shadows and shading with the brush.

After this follows a course of perspective based on projections, a course devised by Mr. F. R. Honey, Instructor of Drawing in the Sheffield Scientific School. In this new method of perspective, every object is first given by its horizontal and vertical projections. The point of sight and all lines of sight are projected on the same planes. The picture plane, always in front of the object, is then introduced, cutting the planes or surfaces of sight, and the intersection of the plane with the visual surfaces is found by projections. A course of graphical instruction in warped surfaces, including all the more difficult problems of Descriptive Geometry, completes the system.

It will be seen that this course embraces two full years for students of Engineering and Architecture, before they are allowed to apply the knowledge gained to composite structures in their

own professional line. But with this preliminary training the student is prepared to enter upon the application of the principles he has learned to the special art or profession which he is to follow. The third year is devoted to this kind of drawing, but the student is no longer under a drawing-master, but under the instructor in the particular course he has chosen. The special principles of another art or profession are now the main objects to be pursued, the drawing being only a means to an end. This final course is not, therefore, to be considered as a part of the course of drawing, but a course of special study and practice in composition and design. Models are now introduced, but they are not models taken up at random, but such as illustrate certain principles of construction. The Civil Engineer takes measurements of some well-constructed bridge, or describes and illustrates by drawings of his own the various methods of making the foundations and superstructure of some public building or other Engineering work; while the Architect, following a similar course, may be prepared to extend his studies to the preparation of designs. Students of Dynamic Engineering require models illustrating the construction of joints or movable pieces, pillow-blocks, steps, and other bearings or typical parts of machinery, the models being accurately made to a scale, and in conformity with the best practice. The construction of foundry patterns is also introduced, until finally the complete construction of an engine, or furnace, or water-wheel, becomes a natural and simple process. It is in this final practice that the principles of mechanics, the strength and qualities of materials, the laws of motion and force, and the general principles of artistic design are brought into requisition.

Alterations in Sheffield Hall, and Enlargement of the Laboratories.

During previous years the limited extent of the accommodations at the disposal of the Governing Board has been felt in nothing more seriously than in the section of Chemistry, and the sciences depending upon it. With increasing classes the deficiencies in this respect were becoming each year more noticeable; and the completion of the new building came just in time, not only to relieve the pressure upon the already crowded accommodations of this department, but to furnish additional facilities which, though long needed and demanded, could not previously be given. With

this purpose in view several of the rooms in the old building were during the summer vacation altered and refitted. In particular, the large lecture room in the third story was changed into a laboratory of Elementary Chemistry, with accommodations for ninety-six students, for the exclusive purpose of furnishing instruction to the members of the Freshman class. This was thoroughly equipped throughout, so as to be made entirely independent of any other laboratory. That portion of the laboratory of Analytical Chemistry which had previously been occupied by the Freshman class, was now taken possession of and applied to its proper use as a place of instruction for more advanced students. It may serve to illustrate the limited nature of the accommodations by which the growth of this section of the school has been prevented from reaching its full natural development, to state that all of the space vacated was immediately filled by the increased number of students desiring to follow this particular course. Not only this, but the additional accommodations, we regret to say, proved insufficient, and the Governing Board were under the necessity of declining several applications to work in it. It was, moreover, found necessary at the end of the first term to remove the students in Physiological Chemistry to the Chemical lecture room, that being temporarily converted into a laboratory. It is now the intention of the Governing Board to fit up an additional room, No. 13, in the second story, to be used as a laboratory of Physiological Chemistry. And in view of the fact that still further instruction will speedily be required in Organic Chemistry, it will doubtless be found necessary, as soon as the means at our disposal will permit, to take possession of the whole of the first floor of Sheffield Hall for the purpose of furnishing instruction in the various branches of this department.

Part of Room No. 18, previously used as a drawing room, has also been set off and fitted up as a laboratory for Determinative Mineralogy and Blow-pipe Analysis. During the past year instruction has been regularly given to fifty-four students in this branch.

Up to the present time there had also been a difficulty in making a full use of the large collection of maps and atlases belonging to the school, from the fact of their being no place where they could be placed and arranged so as to be consulted with facility. Part of Room No. 5 was accordingly set aside for this purpose, and in this eight cases were built for the reception of all

maps and charts belonging to the institution. Three of these cases are each five feet high, four and a half feet wide, and three and a half feet deep. In these are sliding shelves or trays, thirty-eight by fifty-two inches, and four inches apart, for the accommodation of maps and charts in flat sheets and for relief maps. Above these are three other cases of the same width and depth, two of which have fixed shelves for the reception of smaller rolled maps, and the third for atlases. The remaining two cases, each about three feet wide and eighteen inches deep, extend from floor to ceiling, and are for the reception of larger maps mounted on rollers. The arranging and cataloguing of this collection have been begun.

An extensive addition has also been made to the shelf-capacity of the library.

Reorganization of the Select Course.

The facilities furnished by the new building not only enabled the Governing Board to add largely to the completeness of each of the separate courses, but led them to carry into execution a project long entertained for thoroughly reorganizing the course in select studies (Course h.) A committee was accordingly appointed early in the second term to take this matter into consideration, and on the 28th of March, 1874, their report was presented to the Governing Board and unanimously adopted. It was determined, while giving a general knowledge of the elements of several sciences, to make one science in particular more prominent than the rest; and Geology, as involving to a greater or less extent the study of several, was selected. The course is arranged in conformity with the following plan. Two terms of Junior year are devoted to Descriptive Mineralogy and Blow-pipe Analysis; and during the same two terms Physical Geography and Astronomy are also studied. The third term Zoölogy and Botany are begun, the study of both being accompanied with excursions. Zoölogy also extends through the first two terms of Senior year, and during the last term Meteorology. With the beginning of this same year Geology is begun, and continues without intermission through the third term, accompanied at proper seasons of the year with excursions. It is hoped by this course not simply to give to students a more or less complete knowledge of the elements of these sciences, but to fit those who desire to become

specialists in Geology, or any one of the sciences more closely allied to it, to enter upon their graduate studies with a respectable amount of suitable preparatory knowledge. The general studies previously pursued by the Select Course, such as French, German, Linguistics, History, Political Economy, and English Literature, will continue to be pursued as heretofore. This change in the course takes place at the beginning of the next Academic year. But one result of the reorganization is the continuation of the study of German through the third term of Junior year for the whole class, and the arrangement in regard to this particular study went into effect this year.

Addition to the Corps of Permanent Instructors.

At the meeting of the Corporation in June, 1873, Mr. John E. Clark, who had for the past year been instructor in the school, was elected to the Professorship of Mathematics, at the request of the Governing Board. Prof. Clark was graduated at the University of Michigan in 1856, and subsequently had been a professor of mathematics in that institution and in Antioch College, Ohio. At the time of his first becoming connected with the Scientific School, he was attached to the Government Survey of the Northwestern Boundary.

The Library.

Among the most important gifts which have been made to the Library during the year are two large volumes of plates of the sections of the several lines of railways in Ireland, executed under the direction of the Irish Railway Commission; and one large volume of maps and plates of the United States Lighthouses; both of which were the gifts of Prof. John F. Weir of the Yale School of Fine Arts. Besides these, the Library has received two volumes of the Geological Survey of Ohio from Mr. Charles P. Taft of Cincinnati, and a number of important official works from Prof. F. A. Walker.

The accession of books by purchase has been comparatively small, the income being in a great measure exhausted by the subscription to the current scientific periodicals, and the expense of binding back volumes of them which have been for years accumulating. In spite of the large number of periodicals taken, the professors in the school have been and are under the necessity of

supplementing them by subscription to the journals especially needed in their several departments, which the Library fund has not been large enough to furnish. These, though the present property of the professors, are mainly kept in the building and are always accessible for consultation.

The number of books having increased considerably during the past two years, it was found necessary to increase still further the accommodations for receiving them. During the summer vacation, accordingly, an additional number of shelves was added, capable of containing about three thousand volumes.

Instruction in the Use of the Plane Table.

The Superintendent of the Coast Survey, Prof. Pierce, having again given permission to the assistant in charge of the survey of the region about New Haven, Mr. Richard Meade Bache, to furnish instruction in the use of the plane table and in field work, a class was formed for this purpose from the students of the Scientific School. The summer vacation was spent by them in this study. Mr. Bache has courteously furnished the Governing Board with a report of the result of the instruction, in which he expresses his thorough satisfaction with the work done, and the zeal and ability displayed by the members of the party, and also states that whenever practicable he has employed graduates or undergraduates of the Scientific School in the surveys of this region as the best *personnel* at his disposal. From Mr. Bache's report it appears that the first week in July was devoted to placing signals; the plane table work then began, and was finished on the 6th of September. In this time the survey of Oyster Point, with the exception of the levelling, was executed upon the scale of $\frac{1}{1200}$, each member of the party in turn using the instrument. The statistics of the work are:

Area,	201.8 acres.
Principal shore lines,	3.39 miles.
Shore lines of creeks, ditches,	2.18 miles.

The map executed in ink by Mr. N. B. Craig, who from the first was employed by the Coast Survey, was contributed to the Harbor Commission.

Contributions to the Study of the New Haven Region.

For the sake of enabling the Governing Board to add still further to the geographical data of this region contained in their

Seventh Annual Report, Mr. Bache has also kindly furnished the following list of positions and distances, determined (with the exception of East and West Rocks) under his direction last summer by Mr. Horace Andrews, with a six-inch Gambey theodolite, reading to 5″, by 374 sets of angles of six repetitions each.

(*a.*) *Geographical Positions in the Vicinity of New Haven, Conn.*

Name of Station.	Latitude.			Longitude.		
	°	′	″	°	′	″
East Rock,	41	19	40.046	72	54	06.033
West Rock,	41	19	54.034	72	57	21.743
Bigelow's Chimney, Fair Haven,	41	18	07.230	72	53	43.926
South Church, near Oyster Point,	41	17	51.081	72	55	32.613
Forbes' Signal, east end Tomlinson's Br.,	41	17	45.003	72	53	47.110
Oyster Point Signal,	41	16	56.060	72	55	28.711
Custom House Square Flag-pole,	41	18	00.420	72	55	06.351
Car Shop small Chimney (north),	41	17	39.133	72	55	17.197
Long Wharf Light House,	41	17	31.416	72	54	36.207
Canal Dock Signal, white top derrick,	41	17	35.905	72	54	32.442
First Congregat'l Church, Fair Haven,	41	18	32.387	72	53	17.856
Fair Haven School House Cupola,	41	18	32.793	72	53	06.023
Baldwin's Cupola, east of Quinnipiac,	41	17	40.243	72	53	21.778
Water Signal (in water near Oyster Pt.),	41	17	17.591	72	55	20.062
Rogers, Smith & Co's Cupola, knob on top,	41	18	07.066	72	54	18.471
Sargent's Cupola, flag-pole,	41	18	01.335	72	54	26.748
St. Patrick's Church,	41	18	28.324	72	54	22.128
Grace Church, Fair Haven,	41	18	23.103	72	53	36.792
Telegraph Pole Signal on Oyster Point,	41	17	07.514	72	55	32.322
Bridge Signal, R. R. Bridge, Oyster Pt.,	41	17	30.885	72	55	38.915
Dike Signal, West River Bridge,	41	16	59.576	72	55	56.278
Fair Haven Baptist Church,	41	18	31.111	72	53	03.529
Lancraft's Cupola, east of Quinnipiac,	41	18	02.757	72	52	57.389

(*b.*) *Distance between Triangulation Points within the New Haven Region.*

		Feet.
East Rock to	West Rock,	14,996.82
"	Bigelow's Chimney,	9,543.11
"	South Church,	12,854.47
"	Forbes' Signal,	11,731.35
"	Custom House Square Flag-pole,	11,082.68
"	Car Shop Chimney,	13.386.94
"	Long Wharf Light House,	13,219.23
"	Canal Dock Signal,	12,723.54
"	First Congregational Church,	7,771.21
"	Baldwin's Cupola,	12,585.36
"	Rogers, Smith & Co's Cupola,	9,457.21
"	Sargent's Cupola,	10,113.66
"	Grace Church,	8,099.90
"	Telegraph Pole Signal,	16,781.76
"	Bridge Signal,	14,868.66
"	Lancraft's Cupola,	11,151.94
West Rock to	South Church,	14,971.68
"	Forbes' Signal,	20,945.01
"	Custom House Square Flag-pole,	15,456.45
"	Long Wharf Light House,	19,179.07
"	Canal Dock Signal,	19,033.36
"	Fair Haven School House Cupola,	21,170.72
"	Rogers, Smith & Co's Cupola,	17,683.53

		Feet.
West Rock to	Sargent's Cupola,	17,559.52
"	Telegraph Pole Signal,	18,763.44
"	Bridge Signal,	16,474.77
"	Fair Haven Baptist Church,	21,412.48
South Church to	Bigelow's Chimney,	8,453.93
"	Forbes' Signal,	8,075.27
"	Oyster Point Signal,	5,575.98
"	Fair Haven Baptist Church,	12,077.54
"	First Congregational Church, Fair Haven,	11,100.62
"	Fair Haven School House Cupola,	11,956.36
"	Grace Church, Fair Haven,	9,413.94
"	Baldwin's Cupola,	10,045.34
"	Rogers, Smith & Co's Cupola,	5,884.96
"	St. Patrick's Church,	6,567.86
"	Dike Signal,	5,516.31
"	Lancraft's Cupola,	11,904.81
Forbes' Signal to	Oyster Point Signal,	9,201.71
"	Car Shop Chimney,	6,901.08
"	Water Signal,	7,617.60
"	St. Patrick's Church,	5,134.17
Oyster Point Signal to	Water Signal,	2,276.76
" "	Dike Signal,	2,134.21

Additions to the Zoological Collections.

A. E. Verrill, Curator; S. I. Smith, Assistant.

Early in the year the Zoölogical Laboratory was removed from the old Trumbull Gallery to the large and conveniently furnished room provided in North Sheffield Hall. In this room cases have been built to contain the specimens and diagrams used to illustrate the instruction in zoölogy and geology, and also a collection illustrating the fauna of New England. These collections are, as yet, only partially arranged. The number of students who have had regular instruction and practice in the laboratory during the year has varied from six to nine. Their work has been mainly in the direction of comparative anatomy.

During the summer vacation, as in the previous two years, the curator and Mr. Smith took charge of the investigation of the marine invertebrates of New England, in connection with and under the auspices of the U. S. Commissioner of Fish and Fisheries, Prof. S. F. Baird. A large party of volunteers aided in this work. Among these were Prof. W. N. Rice, Prof. H. E. Nelson, Prof. J. E. Todd, Mr. J. K. Thacher, and Mr. Franklin Benner, all of whom had previously studied in our laboratory; Dr. P. P. Carpenter, of Montreal, Mr. G. Browne Good, of Middletown, and several others. These investigations were carried on this season in Casco Bay, Maine, and adjacent waters. Very large and valuable collections of the marine animals were made, from

all depths to about 100 fathoms, and these, like those of the previous years, have been sent here for final study and description, and a full series of the specimens is to be permanently retained in our museum. In the autumn another series of dredgings were made in the waters farther off shore, at various depths down to 142 fathoms, by Dr. A. S. Packard and Mr. Caleb Cooke, of Salem, Mass., for the U. S. Fish Commission, on the Coast Survey steamer Bache. Their collection was likewise large and valuable, and has also been sent here for study. Preliminary reports on these collections have been published by the curator in the *American Journal of Science*. During the year the curator, aided by Mr. Smith and Mr. Harger, has also completed a detailed and well illustrated Report on the invertebrata of the southern coast of New England. This has recently been published, both as a part of the first report of the U. S. Commissioner of Fish and Fisheries, and separately, with new paging. This work will greatly facilitate the study of this department of American zoölogy, which has hitherto been peculiarly difficult, and will be a great aid to our own students in zoölogy.

The most remarkable specimen received during the year consists of portions of a gigantic cuttlefish (? *Architeuthis dux* Steenstrup) taken on the coast of Newfoundland, and forwarded, in alcohol, by the Rev. M. Harvey. This specimen consists of one of the long tentacular arms, 24 feet in length, with the large suckers well preserved; several of the shorter arms, five or six feet long; and the head, tail, and portions of the body.

Capt. C. H. Townsend has presented a large and valuable collection of oysters from New Haven Harbor, illustrating their various stages of growth, from those one day old up to four years, and also variations depending upon their place of growth. He also gave several shells and skulls of sea-turtles; jaws of sharks, etc.

Mrs. Sarah Abraham has sent an interesting collection of shells, etc., from Natal, collected by her sons, Wm. A., Chas. E., and A. J. Abraham.

Professor Marsh presented a variety of reptiles, insects, etc., as well as many osteological specimens collected on his expedition to the Rocky Mountains.

Mr. J. F. Whiteaves has sent duplicates from his dredgings in the Gulf of Saint Lawrence.

From the Smithsonian Institution we have received a collection of skins of Sciuridæ, illustrating the monograph by Mr. J. A. Allen.

A valuable collection of authentically named Crustacea, mostly from the Pacific and Indian Oceans, has been received from the Museum of Paris, through M. Alphonse Milne-Edwards, in exchange for a collection sent to that institution.

A collection of Crustacea and Echinoderms from the Pacific Ocean, collected by the late Wm. Harper Pease, Esq., was sent by Dr. P. P. Carpenter, in exchange.

The osteological collection has been very much increased during the year, chiefly by the numerous gifts from Professor Marsh.

Professor Dana has given a large number of pamphlets and books.

Many other additions, of less importance, have been made, which will be enumerated elsewhere.

Several collections have been sent, in exchange, to other institutions. Among these are a collection of Crustacea, sent to the University of Christiania; a collection of Crustacea, sent to the Museum of Paris; and a collection of New England marine invertebrates, sent to Mr. J. F. Whiteaves.

Additions to the Geological Collections.

O. C. Marsh, Curator; O. Harger, Assistant.

Large additions have been made to the geological collections during the past year, the most important of which have been from the west, and mainly from the Tertiary deposits of that region. A party from the college, in charge of the curator, spent a great portion of the last summer exploring the Tertiary lake basins of Nebraska, Wyoming, Utah and Oregon, visiting also later in the season Colorado and the Cretaceous deposits of Kansas, and securing for the Museum a large collection of vertebrate fossils from these interesting localities.

Among the more important specimens obtained in this region may be mentioned a nearly perfect skull of a gigantic Rhinoceros-like animal, described and figured by the curator in the *American Journal of Science*, under the name of *Brontotherium ingens*. Very important additional remains of the *Dinocerata* were also obtained, including a perfect lower jaw, thus completing our knowledge of the dentition of these animals, and deciding many other important questions in regard to their anatomy. The first remains of Edentates yet discovered in the Tertiary of this country, several new and highly interesting species of fossil horses, together with a large number of other mammals, birds, reptiles, and fishes, were among the results of this expedition.

A large and expensive collection, mostly of foreign vertebrate fossils, has also been obtained from Europe, including a very perfect Pterodactyl from the lithographic slates of Eichstadt, Bavaria, the first specimen discovered showing the membrane of the wings. Unfortunately, for want of room, very few of these acquisitions can, at present, be placed on exhibition.

Valuable additions to the osteological collection of this department have also been made during the year. Among these may be mentioned two skeletons of the Rocky Mountain goat, from Rev. Thomas Condon, of Oregon, several Mexican tapirs, skeleton of an aye-aye, a gorilla and a large number of other monkeys, South American rodents, and birds. Mr. G. B. Grinnell, as in former years, has rendered important aid toward increasing the collection in this department.

Many other additions have been made, both to the geological and osteological departments of the Museum, all of which will be fully acknowledged elsewhere.

Additions to the Museum of Archæology.

The collections in this department have been largely increased during the year, although no opportunity is, as yet, afforded for making them available for study. Most of the additions during the year have been from various parts of this country, illustrative of the Indian and other earlier races of the continent, and especially of the west, where large collections of great archæological and ethnological value were secured by the party in charge of the curator. Many other acquisitions will be acknowledged in the list of donations.

Additions to the Mineralogical Collections.

G. J. Brush, Curator.

Among the more noteworthy additions to the mineralogical collection are a suite of crystallized minerals from the Argentine Republic, the gift of Dr. A. Stelzner of Cordova; a grand specimen of Apophylite from the Ghauts, the gift of Dr. N. Maskelyne of the British Museum; a suite of crystallized Wulfenite found at Tecoma Mine, Utah, obtained by purchase, and a mass of crystallized barytes of 250 lbs. weight, from Cheshire, Conn., the gift of Messrs. J. Lanyon and John H. Leeds.

Public Lectures.

The eighth annual course of lectures to mechanics and others was given during the past year in the new lecture room in North Sheffield Hall. The lecturers and their subjects are indicated in the annexed programme.

I.	Mon.,	Feb. 2.	Extinct Volcanoes of the Pacific States,	W. H. Brewer.
II.	Thurs.,	" 5.	Motion,	C. S. Lyman.
III.	Mon.,	" 9.	The Ancient Lake Basins of the Rocky Mountains,	O. C. Marsh.
IV.	Thurs.,	" 12.	Modern English,	T. R. Lounsbury.
V.	Mon.,	" 16.	Milk,	S. W. Johnson.
VI.	Thurs.,	" 19.	Sea-Weeds,	D. C. Eaton.
VII.	Mon.,	" 23.	Extinct Volcanoes of the Pacific States,	W. H. Brewer.
VIII.	Thurs.,	" 26.	Strength and Elasticity of Materials,	W. A. Norton.
IX.	Mon.	March 2.	Results of the Investigations of the U. S. Fish Commission,	A. E. Verrill.
X.	Thurs.,	" 5.	Steel,	G. J. Brush.
XI.	Mon.,	" 9.	The Story of Biela's Comet,	H. A. Newton.
XII.	Thurs.,	" 12.	Common Sense,	President Porter.
XIII.	Mon.,	" 16.	Animal Mechanics,	W. P. Trowbridge.
XIV.	Thurs.,	" 19.	Pictures out of the Census,	F. A. Walker.

Necessity for Increased Endowments.

The Governing Board are again under the necessity of reminding the friends of the institution of the need of increased endowments if its efficiency is to be maintained. In spite of additions to the requirements in preparatory studies, the number of applicants for admission every year steadily increases; every year the pressure upon the limited resources of the school becomes heavier and heavier; every year the duties devolving upon its instructors assume a more burdensome character. Gratifying as it necessarily is to the members of the Governing Board to find the school steadily growing in numbers and reputation, they can not shut their eyes to the fact that its efficiency may to a greater or less extent be impaired by its very success, unless help is furnished from outside sources. The fees received from an increased number of students are utterly inadequate to pay for the expense of procuring additional instructors; and no satisfactory instruction can be given by men whose time and energies are so absorbed in the teaching of large numbers, that they are unable to keep up with the progress of knowledge and investigation in the special callings which they have chosen. Buildings, and collections, and apparatus are absolutely essential to the success of a school of

science; its progress will be checked, if not entirely prevented, if these are not provided; but after all, it must not be forgotten that the true strength of every institution lies in the efficiency and ability of its teaching force and the character of the instruction which is imparted. It is to the desirability of strengthening the school in this respect that the attention of the friends of the institution is specially called. There are several departments in which it is of the first importance that fuller instruction should be provided. The foundation of several new professorships is urgently demanded. And the necessity is the more urgent because in some of these instances persons fully fitted to fill the positions are known to the Governing Board, and can be now secured; in the necessarily great scarcity of such material, no school can safely let slip opportunities for the acquisition of thoroughly competent men. In no quarter can gifts to the institution be made more advantageously than by the endowment of new chairs, or by contributions to the permanent fund of the institution which will enable the Governing Board to provide for additional instruction in every department, where fuller instruction is demanded.

Gifts to the Institution.

In addition to a large number of maps and atlases, and a portfolio of plates previously presented but unacknowledged, the School has received from President D. C. Gilman, of the University of California, a model, executed by Prof. J. D. Whitney, of the mountain in the Yosemite Valley, known as the Half Dome. To the same source we are also indebted for the mounting and framing of twelve large photographs of California scenery, which were presented to this institution by Mr. C. C. Watkins, the artist.

Anniversary.

The anniversary exercises were held in North Sheffield Hall on the evening of Monday, June 23, 1873. Eight theses were selected for public reading.

The candidates for degrees, with the subjects of their theses, are given in the following schedule. Those marked with an asterisk were read in the evening.

CANDIDATES FOR DEGREES,

WITH THE SUBJECTS OF THEIR GRADUATING THESES.

DOCTORS OF PHILOSOPHY. (2)

AUGUSTUS JAY DUBOIS, C.E., *New Haven.* A general Discussion of Strains in Girders.

CHARLES SHELDON HASTINGS, Ph.B., *Hartford.* On Telescopic Eye-pieces.

CIVIL ENGINEERS. (2)

GEORGE BENJAMIN CRITTENDEN, Ph.B., *New Haven.* Design for a Mansard Roof Truss.

HARRISON WHEELER LINDSLEY, Ph.B., *New Haven.* Design of a Bowstring-Girder Drawbridge.

DYNAMIC ENGINEERS. (2)

JOSEPH FREDERIC KLEIN, Ph.B., *New Haven.* On the Economical Use of Steam.

THOMAS WILLIAM MATHER, Ph.B., *New Haven.* Design for a Boat Engine.

BACHELORS OF PHILOSOPHY. (26)

JOHN WINTHROP AUCHINCLOSS (Select), *New York City.* On the Railroad Interests of the United States.

EDGAR HENRY SUMMERFIELD BAILEY (Chemistry), *Middlefield.* On the Minerals Constituting a Rock from Litchfield, Me.

ALVAH WEED BROWN (Civil Engineering), *Englewood, N. J.* On Steel versus Iron Rails.

MOSES BULKLEY (Select), *Brooklyn, N. Y.* On the Development of Trial by Jury.

*WILLIAM RICHTER COMINGS (Dynamic Engineering), *New Britain.* On Steam Boilers and their Construction.

FILLMORE COGSWELL (Civil Engineering), *Marble Dale.* On Narrow Gauge Railroads.

WILLIAM ALLEN COWLES (Civil Engineering), *New Haven.* On the N. Y. and N. H. R. R. Bridge over the Housatonic River.

*CHARLES ADAMS CRAGIN (Dynamic Engineering), *Wallingford.* On the Silk Manufactures of the United States.

*NEVILLE B. CRAIG, B.A. (Civil Engineering), *Pittsburg, Pa.* On the Railway Bridge over the Connecticut River at Middletown.

ROBERT JOHN CURREY (Select), *San Francisco, Cal.* On some of the Influences of Chinese Immigration in the United States.

FRANCIS URQUHART DOWNING, B.A. (Dynamic Engineering), *New Haven.* On the Coal Supply of the United States.

HARRY TAYLOR GAUSE (Select), *Wilmington, Del.* On the Rise and Development of the Freedom of the Press.

*EDWARD JULIUS HALL (Dynamic Engineering), *Buffalo, N. Y.* On the Transmission of Power by Compressed Air.

HENRY SHEAFF HOYT (Select), *Staatsburg, N. Y.* On the Mound Builders of America.

*ROBERT JAFFRAY (Select), *New York City.* On English Society in the XIVth Century, as Illustrated in the Writings of Langland and Chaucer.

WILLIAM HAMPDEN JENKS (Dynamic Engineering), *Brookville, Pa.* On the Steam Engine Indicator.

GEORGE CHRISTOPHER MOORE (Dynamic Engineering), *Birmingham.* On Fly-Wheels.

WILLIAM JOSIAH PARKS (Select), *Brooklyn, N. Y.* On some proposed Methods for the Representation of Minorities.

BENJAMIN POMEROY (Dynamic Engineering), *Southport.* On the Use of Wave Lines in Ship Construction.

SAMUEL ROCKWELL (Civil Engineering), *Bridgehampton, N. Y.* On Cast-Iron Cylinders for Piles and Piers.

AMORY EDWARDS ROWLAND (Dynamic Engineering), *Brooklyn, N. Y.* On Steam Gauges.

EDGAR CAMP SAVAGE (Dynamic Engineering), *West Meriden.* On Valve-Gearing.

*WILLIAM LUCIEN SCAIFE (Civil Engineering), *Pittsburg, Pa.* On Fire-Proof Structures.

ALFRED LEWIS SELLERS (Dynamic Engineering), *Westchester, Pa.* On Steam Boiler Explosions.

CHARLES THOMPSON SMITH (Civil Engineering), *New York City.* On the Beach Pneumatic Tunnel.

LEWIS RODNEY TAYLOR (Civil Engineering), *Hamilton, Va.* On Wire-Rope Tramways.

*EDWARD ALLEN WILSON, B.A. (Civil Engineering), *St. Louis, Mo.* On Artificial Building Stone.

*HENRY GOODRICH WOLCOTT (Select), *Fishkill, N. Y.* On the Transit of Venus.

PRIZES.

The following prizes were announced at the anniversary.

CLASS OF 1873.

For excellence in German, the prize awarded to WILLIAM L. SCAIFE, *Pittsburg, Pa.*

For excellence in French, the prize awarded to ROBERT JAFFRAY, *New York City.*

For excellence in Civil Engineering, the prize awarded to WILLIAM L. SCAIFE, *Pittsburg, Pa.*

CLASS OF 1874.

For excellence in the Mathematics of Junior Year, the prize divided between ALLEN B. HOWE, *Troy, N. Y.*, and CHARLES J. MORSE, *Poland, O.*

CLASS OF 1875.

For excellence in all the studies of Freshman Year, the prize awarded to WILLIAM A. PRATT, *New Haven;* with honorable mention of GEORGE R. KLEEBERGER, *Apple River, Ill.*

For excellence in German, the prize awarded to CHARLES W. FENN, *Portland, Me.;* with honorable mention of GEORGE R. KLEEBERGER, *Apple River, Ill.*

For excellence in Mathematics, the prize awarded to CHARLES HILDEBRAND, *New Haven.*

For excellence in Physics, the prize awarded to GEORGE L. BROWNELL, *East Haddam.*

For excellence in Mechanical Drawing, the prize divided between JOHN G. BRAMLEY, *Bovina, N. Y.*, and WILLIAM A. PRATT, *New Haven;* with honorable mention of FRANK T. CHAMBERS, *Wilmington, Del.*

PROGRAMME OF STUDIES,

AND

CATALOGUE,

For the College Year 1873--74.

CALENDAR.

1873.		
11 Sept.	Thursday,	First Term begins.
19 Dec.	Friday,	First Term ends.
1874.		**Winter Vacation of Two Weeks.**
3 Jan.	Saturday,	Second Term begins.
2 April,	Thursday,	Second Term ends.
		Spring Vacation of Two Weeks.
16 April,	Thursday,	Third Term begins.
23 June,	Tuesday,	Meeting of Appointing Board.
23 June,	Tuesday,	Anniversary.
25 June,	Thursday,	Commencement.
26, 27 June,	Friday, Sat.,	Examination for Admission.
		Summer Vacation of Eleven Weeks.
8, 9 Sept.	Tues., Wed.,	Examination for Admission.
10 Sept.	Thursday,	First Term begins.
17 Dec.	Thursday,	First Term ends.

ABBREVIATIONS.

S. H. - - - - - - Sheffield Hall.
N. S. H. - - - - - North Sheffield Hall.
TR. - - - - - - Treasury Building.
D. - - - - - - Durfee College.
F. - - - - - - - Farnam College.
S. M. - - - - - - South Middle College.
D. H. - - - - - - Divinity Hall.

In the buildings belonging to the Sheffield Scientific School, the rooms numbered from 1 to 21 are in Sheffield Hall: from 26 to 58 in North Sheffield Hall.

Corporation of Yale College.

he Governor and Lieutenant-Governor of the State are *ex-officio* members of the Corporation.

PRESIDENT.

REV. NOAH PORTER, D.D., LL.D.

FELLOWS.

HIS EXCELLENCY CHARLES R. INGERSOLL, B.A., NEW HAVEN.
HIS HONOR GEORGE G. SILL, M.A., HARTFORD.
REV. LEONARD BACON, D.D., LL.D., NEW HAVEN.
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Professors.

ARRANGED IN THE ORDER OF THEIR GRADUATION.

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Botany. (41 N. S. H.) Sachem st., c. Prospect

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Metallurgy and Analytical Chemistry. (13 S. H.) 189 Temple st.

ADDISON E. VERRILL,
Zoölogy and Geology. (42 N. S. H.) 148 College st.

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ADDITIONAL TO THE GOVERNING BOARD.

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MARK BAILEY,
Elocution. (150 P.) 185 Temple st.

JOHN H. NIEMEYER, Professor in the Yale School of the Fine Arts,
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FREDERIC R. HONEY,
Descriptive Geometry and Projection Drawing. 55 N. S. H.

SIDNEY I. SMITH,
Zoölogy. (42 N. S. H.) 148 College st.

DANIEL H. WELLS,
Mathematics. 99 Bradley st.

OSCAR HARGER,
Palæontology. (4 TR.) 42 S. M.

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THEOPHIL M. PRUDDEN,
Chemistry. 14 S. H.

GEORGE W. HAWES,
Mineralogy. 14 S. H.

EDGAR C. SAVAGE,
Mechanical Drawing. 46 N. S. H.

SAMUEL T. TYSON,
Analytical Chemistry. 14 S. H.

BY AUTHORITY OF THE SUPERINTENDENT OF THE SURVEY.

RICHARD M. BACHE, of the U. S. Coast Survey,
The Use of the Plane Table. 82 Wall st.

GRADUATE STUDENTS.

Jacob Jackson Abbott, PH.B.	*New Haven,*	29 Prospect st.
Philip Henry Adee, B.A.	*Westchester, N. Y.*	6 Library st.
Henry Prentiss Armsby, Worcester Free Ind. Institute.	*Millbury, Mass.*	172 George st.
Leonard S. Austin, PH.B.	*Stratford,*	Stratford.
Edgar Henry Summerfield Bailey, PH.B.	*Middlefield,*	46 N. S. H.
Alexander H. Bezjian, Prof. of Physical Science in the Central Turkey College,	*Aintab, Syria,*	120 College st.
Alvah Weed Brown, PH.B.	*Englewood, N. J.*	134 College st.
Fillmore Cogswell, PH.B.	*Marble Dale,*	136 College st.
William Righter Comings, PH.B.	*New Britain,*	187 Temple st.
William Allen Cowles, PH.B.	*New Haven,*	19 Park st.
Neville B. Craig, B.A., PH.B.	*Pittsburgh, Pa.*	33 Prospect st.
Francis Urquhart Downing, B.A., PH.B.	*New Haven,*	83 Olive st.
Charles Benjamin Dudley, B.A.	*New Haven,*	16 S. H.
James Ridgway Gawthrop, PH.B.	*Northbrook, Pa.*	27 Mansfield st.
George B. Grinnell, B.A.	*New York City,*	6 Library st.
Oscar Harger, M.A.	*New Haven,*	42 S. M.
George Wesson Hawes, PH.B.	*Boston, Mass.*	14 S. H.
Henry Allen Hazen, B.A. Dartmouth College,	*New Haven,*	28 Ward st.
John Oxenbridge Heald, B.A.	*Orange, N. J.*	6 Library st.
William Hale Herrick, B.A. Williams College,	*W. Charleston, Vt.*	47 N. S. H.
Frederick H. Hoadley, B.A.	*New Haven,*	179 Church st.
Henry Sheaff Hoyt, PH.B.	*Staatsburgh, N. Y.*	488 Chapel st.
Edward Hopkins Jenkins, B.A.	*Falmouth, Mass.*	47 N. S. H.
William Hampden Jenks, PH.B.	*Brookville, Pa.*	22 York sq.
Joseph Taplin Lovewell, B.A.	*Whitewater, Wisc.*	34 Prospect st.
Frank Oscar Maxson, PH.B.	*San Francisco, Cal.*	8 Lock st.
John Beale Mills, B.A.	*New Haven,*	42 Elm st.
Samuel Roseburgh Morrow, B.A.	*New Haven,*	153 P.
Charles Theodore Morse, PH.B.	*New Haven,*	151 York st.
Daniel Hobart Pierpont, PH.B.	*North Haven,*	145 Olive st.
Theophil Mitchell Prudden, PH.B.	*New Haven,*	14 S. H.
Edgar Camp Savage, PH.B.	*West Meriden,*	46 N. S. H.

Villiam Lucien Scaife, PH.B.	*Pittsburgh, Pa.*	8 Lock st.
ieorge Henry Seyms, B.A. Trinity College,	*Hartford,*	90 Grove st.
oseph John Skinner, PH.B.	*New Haven,*	58 N. S. H.
Ienry Pease Starbuck, B.A. Harvard University,	*Nantucket, Mass.*	42 York sq. pl.
ames Henry Webb, B.S. Mass. Agric. College,	*Hamden,*	Hamden.
Ienry Goodrich Wolcott, PH.B.	*Fishkill, N. Y.*	134 College st.
Villiam Curtis Wood, M.A.	*New Haven,*	102 N.
ndrew Harvey Young, B.A. Hanover College,	*Hanover, Ind.*	170 George st.

GRADUATES, 40.

UNDERGRADUATE STUDENTS.

SENIOR CLASS.

Nathan Edward Beckwith,	*New Haven,*	64 Whitney av.
Moses Taylor Belcher,	*Garrison's, N. Y.*	55 Trumbull st.
Charles Cook Brewster,	*Norwich,*	55 Trumbull st.
Edward Brush,	*Greenwich,*	25 Prospect st.
Arthur Bucklin Claflin,	*Boston, Mass.*	159 Temple st.
Franklin Edwards,	*Northampton, Mass.*	84 Wall st.
Charles Howard Fitch,	*New Haven,*	58 Olive st.
Edwin Horace Forbes,	*Cromwell,*	125 Dwight st.
LeRoy Gale,	*New York City,*	87 Trumbull st.
Jacob Houtz Grove,	*Fredericksburg, Pa.*	23 Prospect st.
Vincent Gilpin Hazard,	*West Chester, Pa.*	35 High st.
Frazier Davenport Head,	*St. Paul, Minn.*	94 Grove st.
Frank Leroy Holt,	*Rockville,*	105 Park st.
Allen Brewer Howe,	*Troy, N. Y.*	134 College st.
Henry Hun,	*Albany, N. Y.*	23 Prospect st.
Lorenzo M. Johnson,	*Rochester, Mass.*	23 Prospect st.
Henry Jarvis Kellogg,	*Milford,*	25 Prospect st.
Charles Hittell Killinger,	*Lebanon, Pa.*	173 Temple st.
Beverly Livingston,	*New York City,*	162 York st.
William Pitt Lynde,	*Milwaukee, Wisc.*	159 Temple st.
William McGrath,	*Bridgeport,*	16 Park st.
Charles James Morse,	*Poland, O.*	46 Hillhouse av.
George Smith Needham,	*Louisville, Ky.*	420 Chapel st.
Eugene Ernest Osborn,	*Norwalk,*	147 York st.
Richard Deane Arden Parrott,	*Greenwood Works, N. Y.*	159 Chapel st.
Claudius Victor Pendleton,	*Bozrah,*	8 Lock st.
Walter Brewster Platt,	*Waterbury,*	165 Temple st.
George Coffin Power,	*Hudson, N. Y.*	83 Olive st.
William Spencer Pratt,	*New Haven,*	17 Hazel st.
William Henry Reynolds,	*New Haven,*	129 York st.
William Rockwell,	*Bridgehampton, N. Y.*	177 Temple st.
William Arthur Rogers,	*Covington, Ky.*	503 Chapel st.
John Muirhead Stewart,	*Peekskill, N. Y.*	19 Park st.
Francis Hill Stillman,	*Plainfield, N. J.*	8 Lock st.
William Richardson Upham,	*Yonkers, N. Y.*	159 Temple st.
Simeon Harrison Wagner,	*West Haven,*	106 Crown st.
John Charles Weber,	*New York City,*	165 Temple st.

SENIORS, 27.

JUNIOR CLASS.

Charles Henry Alling,	*Birmingham*,	106 Wall st.
Caleb Dakin Barrett,	*Amenia, N. Y.*	22½ William st.
Moses Bradstreet Bradford,	*Middletown*,	21 Bradley st.
John Gilbert Bramley,	*Bovina, N. Y.*	14 Lock st.
George Loomis Brownell,	*East Haddam*,	44 York sq.
Amos Avery Browning,	*Norwich*,	8 Lock st.
Charles Stewart Bunce,	*Glastenbury*,	8 Elm st.
Algernon Taylor Burr,	*Westport*,	104 Grove st.
Frank Taylor Chambers,	*Wilmington, Del.*	122 College st.
Edward Benjamin Chandler,	*Woodstock*,	30 Dixwell av.
John Henry Chapman,	*New York City*,	46 Elm st.
William Alexander Christie,	*Newport, R. I.*	29 Prospect st.
Arthur Eugene Clarke,	*Batavia, N. Y.*	420 Chapel st.
George Rufus Cooley,	*Hamden*,	106 Crown st.
Frederic Augustus Corning,	*Hartford*,	38 High st.
Chambers McKibbin Craig,	*Alleghany City, Pa.*	33 Prospect st.
James Cunningham,	*Pittston, Pa.*	149 College st.
Charles William Fenn,	*Portland, Me.*	136 College st.
Frederic Hodgeman Foote,	*Port Henry, N. Y.*	23 Prospect st.
Charles Hamilton Fox,	*Lansingburgh, N. Y.*	116 College st.
James Freeland,	*New York City*,	92 Grove st.
Luther Henry Gager,	*Coventry*,	209 Elm st.
Robert Francis Gaylord,	*Sherman*,	Room E., D. H.
Livingston Gifford,	*Jersey City, N. J.*	191 Temple st.
Louis Emile Addison Goll,	*Newark, N. J.*	193 Temple st.
Frank Holabird Grant,	*Glastenbury*,	8 Elm st.
John Starr Griffing,	*New Haven*,	114 Chapel st.
William Cornelius Hall,	*Buffalo, N. Y.*	73 Trumbull st.
Henry Mortimer Hastings,	*Oswego, N. Y.*	193 Temple st.
Alfred Pell Haven,	*New York City*,	73 Trumbull st.
Charles Hildebrand,	*New Haven*,	16 Chestnut st.
Thomas Douglas Hoxsey,	*Paterson, N. J.*	27 Prospect st.
William Read Howe,	*Orange, N. J.*	64 Whitney av.
Julian Kennedy,	*Struthers, O.*	30 Bristol st.
Edward Austin Kent,	*Buffalo, N. Y.*	64 Whitney av.
George Reinard Kleeberger,	*Apple River, Ill.*	30 Bristol st.
Wells Cushman Lake,	*Lake Forest, Ill.*	432 Chapel st.
Charles Purdy Lindsley,	*New Haven*,	132 Olive st.

Blanchard Lynde,	*Milwaukee, Wisc.*	191 Temple st.
Albert Sutton Macgregor,	*New York City,*	191 Temple st.
Clarence Fake McMurray,	*Lansingburgh, N. Y.*	116 College st.
Burton Mansfield,	*New Haven,*	50 Lyon st.
Charles Aldworth Maybury,	*Norwalk,*	227 Crown st.
John Charles Olmsted,	*New York City,*	189 Church st.
Edward Day Page,	*South Orange, N. J.*	11 College st.
Frederic Noah Pease,	*Ellington,*	44 York sq.
William Edward Peirce,	*Raleigh, N. C.*	72 Temple st.
Dwight Edward Pierce,	*New Haven,*	120 High st.
George White Polk,	*Odessa, Del.*	64 High st.
William Arthur Pratt,	*New Haven,*	8 Gill st.
William Shugard Righter,	*Newark, N. J.*	187 Temple st.
Walter Coe Roberts,	*New Haven,*	8 Brown st.
William Babcock Sawyer,	*Buffalo, N. Y.*	120 High st.
Richard Sharpe,	*Eckley, Pa.*	64 High st.
Clarence Hoyt Stilson,	*Cleveland, O.*	153 Crown st.
Frederick Moncrieff Turnbull,	*Hartford,*	134 College st.
George Leland Upham,	*Yonkers, N. Y.*	193 Temple st.
Thomas Alfred Vernon,	*Brooklyn, L. I.*	136 College st.
Alonzo Earl Wemple,	*Brooklyn, L. I.*	9 Library st.
William Rodman Wharton,	*Germantown, Pa.*	8 Lock st.
Alfred Newton Wheeler,	*Southford,*	59 Wooster st.
Henry Stacy Whipple,	*Birmingham,*	106 Wall st.
Edward Luther White,	*Waterbury,*	193 Temple st.
George Horace Wilcox,	*West Meriden,*	40 York sq.
Frederick Wood,	*Norwalk,*	227 Crown st.
Kenjiro Yamagawa,	*Japan,*	29 Prospect st.

JUNIORS, 66.

FRESHMAN CLASS.

Samuel Forbes Adam,	*Canaan,*	127 College st.
Halsey Warren Allen,	*Jersey City, N. J.*	94 Grove st.
Evelyn Marcelon Andrews,	*Norwich,*	22 Trumbull st.
Benjamin Phillips Audubon,	*New Haven,*	351 Orange st.
Alvin Driggs Ayers,	*Orange,*	432 Chapel st.
Charles Eben Bacon,	*Middletown,*	125 Dwight st.
Charles Loring Brace,	*Hastings, N. Y.*	189 Church st.
James Henry Brewster,	*New Haven,*	49 Chapel st.
Frank Elwood Brown,	*West Haven,*	West Haven.
William McCulloh Brown,	*Brookline, Mass.*	143 York st.
Willis Browning,	*Norwich,*	8 Lock st.
Hermon Beardsley Butler,	*New York City,*	169 Temple st.
Walter Cleveland Butler,	*New Haven,*	113 Olive st.
Lloyd Joseph Caswell,	*Norwich,*	132 College st.
Clarence Augustus Claflin,	*Hopkinton, Mass.*	167 Temple st.
Sidney William Clark,	*Hartford,*	223 Elm st.
Jocelyn Plant Cleaveland,	*New Haven,*	140 York st.
Frank Welles Crowell,	*Brooklyn, N. Y.*	132 College st.
John Moffat Cunningham,	*Poughkeepsie, N. Y.*	149 College st.
Frederick Perkins Dewey,	*West Haven,*	West Haven.
Charles Dickinson,	*Fordham, N. Y.*	193 Temple st.
George Cornwell Dunham,	*Southington,*	66 Bradley st.
Edward Payson Farren,	*New Haven,*	35 High st.
John Sherman Fitch,	*New Haven,*	46 High st.
Edward Livingston Ford,	*Niagara Falls, N. Y.*	120 High st.
Porter Dwight Ford,	*Washington,*	66 Martin st.
Stanley Forbes,	*San Francisco, Cal.*	81 York st.
Edward Jasper Francke,	*New York City,*	7 Library st.
Robert Jackson Gibson,	*New Haven,*	44 Edwards st.
William Wesley Gibson,	*New Haven,*	44 Edwards st.
Edward Gillette,	*New Haven,*	15 Columbus st.
Charles Cortledge Godfrey,	*Southport,*	7 Library st.
Thomas Milburn Gopsill,	*Jersey City, N. J.*	143 York st.
Jack Hays Hammond,	*San Francisco, Cal.*	8 Elm st.
William Colt Harding,	*Long Meadow, Mass.*	143 Prospect st.
James Lawrence Houghteling,	*Chicago, Ill.*	167 Temple st.
Randell Hunt,	*New Orleans, La.*	132 College st.
Saburo Iwao,	*Kumamoto, Japan,*	84 Wall st.

William Brinkerhoff Jackson,	*Belleville, N. J.*	114 Grove st.
Edward Hine Johnson,	*Jersey City, N. J.*	94 Grove st.
Clifford Pearse Johnston,	*Lake Forest, Ill.*	147 Orange st.
James Tewksbury Law,	*Tarrytown, N. Y.*	146 College st.
John Richard Lingren,	*Chicago, Ill.*	125 Dwight st.
Thomas Howard Linsley,	*West Meriden,*	121 Park st.
John Francis Luby,	*New Haven,*	21 Nash st.
Max Mailhouse,	*New Haven,*	49 Meadow st.
Howard Meyer,	*New York City,*	35 College st.
Frederick Plumb Miles,	*Salisbury,*	127 Crown st.
Hiram Allen Miller,	*New Haven,*	244 Crown st.
James Blair Murray,	*Norwich,*	132 College st.
William Mayo Newhall,	*San Francisco, Cal.*	8 Elm st.
Arthur Edward Nichols,	*Yonkers, N. Y.*	11 College st.
Miles Greenwood Nixon,	*Chicago, Ill.*	176 Temple st.
William Beach Palmer,	*Bridgeport,*	Bridgeport.
Edward Hunt Phipps,	*New Haven,*	56 Olive st.
Cyrus Polk,	*Odessa, Del.*	64 High st.
William Allen Pratt,	*Montclair, N. J.*	153 Crown st.
Nathaniel Chapin Ray,	*West Haven,*	271 Chapel st.
James Tracy Richards,	*New York City,*	120 College st.
Charles Brigham Rockwood,	*Indianapolis, Ind.*	114 Grove st.
George Trinble Rodgers,	*Brookville, Pa.*	8 Lock st.
Edward Larned Ryerson,	*Chicago, Ill.*	167 Temple st.
Andrew Gilbert Sheak,	*Binghampton, N. Y.*	81 York st.
William Atwood Shelton,	*Birmingham,*	144 Elm st.
Edward Gordon Sherman,	*Morristown, N. J.*	114 High st.
Charles David Seeberger,	*Chicago, Ill.*	147 Orange st.
Cornelius Sleight,	*Sag Harbor, N. Y.*	9 Library st.
George Watson Smith,	*Chicago, Ill.*	167 Temple st.
LeGrand Smith,	*Chicago, Ill.*	167 Temple st.
James Clifton Stone,	*Leavenworth, Kan.*	167 Temple st.
Howard Steadman Talcott,	*Hartford,*	147 York st.
George Franklin Taylor,	*Willimantic,*	38 High st.
Francis Augustus Terry,	*Lyme,*	133 Dwight st.
Allan Mason Thomas,	*Wickford, R. I.*	33 Prospect st.
Frederick William Vanderbilt,	*New York City,*	85 College st.
Charles Williams Van Vleck,	*Cincinnati, O.*	416 Chapel st.
Alfred Elisha Walker,	*Orange,*	85 Church st.
William Oakley Wallace,	*Ansonia,*	525 Chapel st.
Charles Alexander Watson,	[illegible]*tford,*	

David Agnew Weyer,	*Madison, Ind.*	170 George st.
David Willard Williams,	*Glastenbury,*	8 Elm st.
Thomas Yeatman,	*New Haven,*	36 Elm st.

FRESHMEN, 82.

SPECIAL STUDENTS NOT CANDIDATES FOR A DEGREE.

Launcelot Winchester Andrews,	*Springfield, Mass.*	462 Chapel st.
Charles Edwin Bogue,	*Crown Point, N. Y.*	187 George st.
Thomas Attwater Bostwick,	*New Haven,*	162 Olive st.
Charles Albert Burt,	*Wallingford,*	169 Temple st.
Russell Henry Chittenden,	*New Haven,*	23 Humphrey st.
Stephen Elijah Churchill,	*Stamford, N. Y.*	42 York sq. pl.
Samuel Fessenden Clark,	*Geneva, Ill.*	27 Prospect st.
Henry Sheldon DeForest,	*Birmingham,*	Birmingham.
Frank R. Eltzner,	*New Haven,*	201 Wooster st.
James Hall Foote,	*Cincinnati, O.*	73 Trumbull st.
Franklin Wilson Hall,	*Killingworth,*	14 Park st.
Abbott Kinney,	*Baltimore, Md.*	New Haven House.
C. G. Knox,	*Yonkers, N. Y.*	New Haven House.
Frederick Anthony Marks,	*Wallingford,*	169 Temple st.
William Henry Porter,	*Norfolk,*	125 High st.
William James Rattle,	*Cleveland, O.*	134 College st.
Charles Waterman Smith,	*Hartford,*	134 College st.
Eliphalet Gilman Storer,	*New Haven,*	6 Trumbull st.
Charles Wall Truslow,	*New York City,*	44 York sq.
Samuel Traquair Tyson,	*Philadelphia, Pa.*	14 S. H.
A. B. Waring,	*Yonkers, N. Y.*	New Haven House.
Henry Ellsworth Wood,	*Joliet, Ill.*	187 Temple st.

SPECIAL STUDENTS, 22.

SUMMARY.

GRADUATES,	40
SENIORS,	37
JUNIORS,	66
FRESHMEN,	82
SPECIAL STUDENTS,	22
TOTAL,	247

SHEFFIELD SCIENTIFIC SCHOOL.

I.

Objects.

THE SHEFFIELD SCIENTIFIC SCHOOL is devoted to instruction and researches in the mathematical, physical, and natural sciences, with reference to the promotion and diffusion of science, and also to the preparation of young men for such pursuits as require especial proficiency in these departments of learning. It is one of the Departments of Yale College, like the law, medical, theological, and art schools, having its separate funds, buildings, teachers, and regulations, but governed by the Corporation of Yale College, which appoints the professors and confers the degrees. It is, in part, analogous to the academic department or classical college, and, in part, to the professional schools.

The instruction is intended for two classes of students:—

I. Graduates of this or of other Colleges, and other persons qualified for advanced or special scientific study.

II. Undergraduates who desire a training chiefly mathematical and scientific, in less part linguistic and literary, for higher scientific studies, or for various other occupations to which such training is suited.

II.

History and Organization.

The School was commenced in 1847. In 1860, a convenient building and a considerable endowment were given by Joseph E. Sheffield, Esq., of New Haven, whose name, at the repeated request of the Corporation of Yale College, was afterward attached to the foundation. Mr. Sheffield has frequently and munificently increased his original gifts, and during the past year, a large additional building, completely furnished throughout, was finished at his expense and presented to the School.

In 1864, by an act of the Connecticut Legislature, the national grant for the promotion of scientific education (under the congressional enactment of July, 1862) was given to this department of Yale College, which thus became "the College of Agriculture and the Mechanic Arts for Connecticut." Since that time, and especially since the autumn of 1869, numerous liberal gifts have

been received from the citizens of New Haven, and from other gentlemen in Connecticut, New York, and St. Louis, for the endowment of the School, and the increase of its collections.

The action of the State led to the designation by law of a State Board of Visitors, consisting of the Governor, Lieutenant-Governor, three senior Senators, and the Secretary of the State Board of Education; and this Board, with the Secretary of the Scientific School, is also the Board for the appointment of students to hold the State scholarships.

At the request of the Governing Board, the Corporation of Yale College has also appointed a Board of Councillors for the School, consisting of a number of gentlemen who have taken a deep interest in its welfare, and have assiduously labored to secure its success.

The Governing Board consists of the President of Yale College and the Professors who are permanently attached to the School. There are several other instructors associated with them, a part of whom are connected with other departments of the College.

III.

Buildings and Apparatus.

The two buildings in which the work of instruction in the Scientific School is carried on are called Sheffield Hall and North Sheffield Hall. These contain a large number of recitation and lecture rooms, a hall for public assemblies and lectures, chemical and metallurgical laboratories, a photographical room, an astronomical observatory, museums, a library and reading room, besides studies for some of the professors, where their private technical libraries are kept.

The following is a summary statement of the collections belonging to the School:—

1. Laboratories and Apparatus in Chemistry, Metallurgy, Physics, Photography, and Zoölogy.
2. Metallurgical Museum of Ores, Furnace Products, etc.
3. Agricultural Museum of Soils, Fertilizers, useful and injurious insects, etc.
4. Collections in Zoölogy.
5. Astronomical Observatory, with an equatorial telescope by Clark and Sons of Cambridge, a meridian circle, etc.
6. A collection of Mechanical Apparatus, constituting the "Collier Cabinet."
7. Models in Architecture, Geometrical Drawing, Civil Engineering, Topographical Engineering, and Mechanics; diagrams adapted to public lectures; instruments for field practice.

8. Maps and Charts, topographical, hydrographical, geological, etc.

The mineralogical cabinet of Professor Brush, the herbarium of Professor Brewer, the collection of native birds of Professor Whitney, and the astronomical instruments of Professor Lyman, are deposited in the building. Professor Eaton's herbarium, near at hand, is freely accessible.

Students are also admitted, under varying conditions, to the College and Society libraries, the College Reading Room, the Cabinet of Minerals and Fossils, the School of the Fine Arts, and the Gymnasium.

IV.

The Library.

The special technical library of the Scientific School consists of about five thousand volumes. Included in this is the "Hillhouse Mathematical Library" of twenty-four hundred volumes, collected during a long series of years by Dr. William Hillhouse, and four years ago purchased and presented to the Institution by Mr. Sheffield. A Catalogue of this collection forms a supplement to the Annual Report of the Governing Board for 1870.

The following scientific journals are received regularly at the Library, and are accessible to all for consultation.

AMERICAN.

Journal of the Franklin Institute.
Engineering and Mining Journal.
Scientific American.
Mining and Scientific Press.
Van Nostrand's Eclectic Engineering Magazine.
Railroad Gazette.
Official Gazette of the U. S. Patent Office.
Bulletin of the National Association of Wool Manufacturers.
American Chemist.
American Journal of Science.

ENGLISH.

Agricultural Gazette, The.
Annals and Magazine of Natural History.
Builder, The.
Economist, The.
Engineer, The.
Engineering.
Farmer's Magazine.
Garden, The.
Gardener's Chronicle, The.
Grevillea.
Iron.
Journal of the Anthropological Institute.

Journal of the Chemical Society.
——— of the Iron and Steel Institute.
——— Quarterly, of Microscopical Science.
——— Quarterly, of Pure and Applied Mathematics.
——— Quarterly, of Science.
Magazine, The Botanical.
Mining Journal, The.
Monthly Notices of the Royal Astronomical Society.
Nature.
News, The Chemical, and Journal of Physical Science.
Philosophical Magazine, The London, Edinburgh, and Dublin.

FRENCH.

Annales de Chimie et de Physique.
——— Nouvelles de la Construction.
——— des Ponts et des Chaussées.
Archives de Zoölogie Experimentale et Generale.
Bulletin de la Société de Géographie.
——— de Société Chemique.
Connaisance des Temps.
Journal d'Agriculture Pratique.
——— de Zoologie.
Mémoires de la Société d'Anthropologie de Paris.
Mondes, Les.
Revue Scientifique.
——— Universelle des Mines.
Technologiste, Le.

GERMAN.

Annalen der Landwirthschaft.
——— der Physik und Chemie.
Archiv für Anthropologie.
Berichte der Deutschen Chemischen Gesellschaft.
Centralblatt Chemisches.
——— Polytechnisches.
Civil-Ingenieur, Der.
Hedwigia.
Jahrbuch, Berliner Astronomisches.
——— über die gesammten Fortschritte der Mathematik.
Journal für reine und angewandte Mathematik.
Milch-Zeitung.
Nachrichten, Astronomische.
Repertorium für Experimental-Physik, etc.
Zeitschrift für Biologie.
——— für Analytische Chemie.
——— für Math. und Naturw. Unterricht.
——— für Wissenschaftiche Zoologie.
Zeitung, Berg-und Hüttenmännische.
——— Botanische.

Niederländisches Archiv für Zoologie.

Numerous scientific journals, not included in this list, can be found in the private libraries of various professors, which are deposited in the building, and are accessible for consultation; and in the College library there are a large number of others, especially of the proceedings of foreign academies and scientific societies.

V.

Instruction for Graduate and Special Students.

Persons who have gone through undergraduate courses of study, here or elsewhere, may avail themselves of the facilities of the School for more special professional training in the physical sciences and their applications, gaining in one, two, or three years the degree of BACHELOR OF PHILOSOPHY, or, in two additional years of Engineering study, that of CIVIL ENGINEER, or of DYNAMICAL ENGINEER.

Or, engaging in studies of a less exclusively technical character, they may become candidates for the degree of DOCTOR OF PHILOSOPHY. The instruction in such cases will be adapted to the particular needs and capacities of each student, and may be combined with that given by the graduate instructors in other departments of the University. This degree is conferred upon those who, having already taken a Bachelor's degree, engage as students in the Department of Philosophy and the Arts for not less than two years in assiduous and successful study. It is not given upon examination to those whose studies are pursued elsewhere. The requirements for it will in some cases exact of the student more than two years of post-graduate labor; so, especially, wherever the course of undergraduate study has been, as in the Scientific School, of less than four years. The candidate must pass a satisfactory final examination, and present a thesis giving evidence of high attainment in the branches of knowledge to which he has attended. A good knowledge of Latin, German and French will be required in all cases, unless, for some exceptional reason, the candidate be excused by the Faculty. The graduating fee is ten dollars.

Subjects likely to receive special attention are suggested as follows:—

Professor NORTON will instruct in celestial mechanics and in spherical astronomy.

Professor LYMAN, in the use of meridional and other astronomical instruments, and in astronomical spectroscopy.

Professor TROWBRIDGE, in the principles of thermodynamics, and the artificial generation, transfer, and utilization of heat as a source of power.

Professor BRUSH, in the analysis and determination of mineral species, and in descriptive mineralogy.

Professor JOHNSON, in theoretical, analytical, and agricultural chemistry.

Professor BREWER, in agriculture and forest culture, in the use of the microscope, and in physical geography.

Professor CLARK, in definite integrals, differential equations, analytical mechanics, the theory of numerical approximations, and the method of least squares.

Professor EATON, in structural and systematic botany, including the North American flora and the description of genera and species.

Professor MARSH, in palæontology and comparative osteology.

Professor WALKER, in public finance and in the statistics of industry.

Professor ALLEN, in analytical chemistry, and in metallurgy.

Professor VERRILL, and Mr. S. I. SMITH, in zoölogy and geology.

The same courses of study are open, for a longer or shorter time, to graduate students who do not desire to become candidates for a degree.

Students who have taken the degree of Bachelor of Philosophy, may obtain the degree of CIVIL or of DYNAMIC ENGINEER at the end of two academical years, by pursuing the following higher course of study and professional training.

The course of study for the degree of CIVIL ENGINEER will comprise

1. Higher Calculus. Higher Geometry. Theory of Numerical Operations.
2. Analytical Mechanics. Mechanics applied to Engineering.
3. A Course of Construction and Design. Projects.
4. Practical Astronomy, with use of instruments, computations, etc.

This course will occupy three academical terms.

To secure the requisite amount of professional knowledge and practice, the candidate will be required to furnish a comprehensive Report of the results of an examination into the existing condition of some special line of constructive art; or to present proper evidence that he has had actual charge in the field, for several months, of construction or surveying parties, or held some responsible position deemed equivalent to this.

An elaborate design must also be submitted of some projected work of construction, based upon exact data obtained from careful surveys made by the candidate, and comprising all the requisite calculations, and the necessary detailed drawings, and accompanied by full specifications of the work to be done, and the requirements to be met by the contractor.

The fee for this degree is five dollars.

The course of study for the degree of DYNAMIC ENGINEER will comprise

1. Higher Calculus, General Theory of Equations and of Numerical Operations.
2. General Principles of Dynamics (Analytical Mechanics). Including special application of these principles to Dynamical problems.
3. Constructions of Machines. Designs.
4. Preparations of theses on special subjects in Dynamic Engineering.

During the second year candidates will be permitted to employ such a portion of their time as may be deemed advisable or necessary in the examination of engineering works and manufacturing establishments, and may also have the privilege of entering upon professional practice, provided it is done with the knowledge and consent of the Professor of Dynamic Engineering, and under such circumstances as shall appear to him to be favorable to professional progress.

An elaborate thesis on some professional subject, with an original design, or project, accompanied by proper working drawings, will be required at the end of the second year.

The fee for this degree is five dollars.

SPECIAL STUDENTS.—For the benefit of those who, being fully qualified, desire to pursue particular studies without reference to the obtaining of a degree, special or irregular students are received in most of the departments of the School; not, however, in the Select Course or in the Freshman Class.

It should be distinctly understood that these opportunities are not offered to persons who are incompetent to go on with regular courses, but are designed to aid those who, having received a sufficient preliminary education elsewhere, desire to increase their proficiency in special branches.

VI.

Instruction for Undergraduate Students.

TERMS OF ADMISSION.—Candidates must be not less than sixteen years of age, and must bring satisfactory testimonials of moral character from their former instructors or other responsible persons.

For admission to the Freshman Class the student must pass a thorough examination in the following subjects:

English Grammar—including spelling and composition.
History of the United States.
Geography.
Latin—Six books of Cæsar's commentaries or their equivalent, and simple exercises in prose composition.

Arithmetic—including the metric system.
Algebra—Davies' Bourdon's, as far as the general theory of equations, or its equivalent.
Geometry—the nine books of Davies' Legendre or their equivalent.
Plane Trigonometry—including analytical trigonometry.

The examinations for admission take place at North Sheffield Hall, on Friday and Saturday, June 26th and 27th; and on Tuesday and Wednesday, September 8th and 9th, 1874. Opportunity for private examination may, in exceptional cases, be given at other times.

COURSES OF INSTRUCTION, occupying three years, are arranged to suit the requirements of various classes of students. The first year's work is the same for all; during the last two years the instruction is chiefly arranged in special courses.

The special courses most distinctly marked out are the following:—

(a.) In Chemistry and Metallurgy;
(b.) In Civil Engineering;
(c.) In Dynamic (or Mechanical) Engineering;
(d.) In Agriculture;
(e.) In Natural History;
(f.) In studies preparatory to Medical Studies;
(g.) In studies preparatory to Mining;
(h.) In Select studies preparatory to other higher pursuits, to business, etc.

The arrangement of the studies is indicated in the annexed scheme.

FRESHMAN YEAR.—INTRODUCTORY TO ALL THE COURSES.

FIRST TERM—*German.*—Whitney's Grammar and Reader. *English.*—Hadley's Brief History of the English Language; Exercises in Composition. *Mathematics.* Olney's University Algebra, Part III, Spherical Trigonometry. *Physics.*—Atkinson's Ganot, with experimental lectures. *Chemistry.*—Eliot and Storer's Manual; Laboratory practice. *Elementary Drawing.*—Practical Lessons in the Art School.

SECOND TERM—*Language, Physics, Chemistry, and Drawing.*—As stated above. *Mathematics.*—Peck's Analytical Geometry. *Physical Geography.*—Lectures.

THIRD TERM—*Mathematics.*—Church's Descriptive Geometry. *Botany.*—Gray's Lessons. Other studies continued. *Political Economy.*—Elementary Lectures. *Drawing.*—Orthographic Projection.

For the Junior and Senior years the students select for themselves one of the following courses:—

(a.) In CHEMISTRY AND METALLURGY.

JUNIOR YEAR.

FIRST TERM—*Theoretical and Organic Chemistry.*—Lectures. *Chemical Analysis.*—Fresenius. Use of Blow-pipe. *Laboratory Practice.*—Qualitative Analysis. Exercises in English Composition. *German. French.*

SECOND TERM—*Laboratory Practice.*—Qualitative Analysis, continued. Quantitative Analysis, begun. *Zoölogy.*—Lectures. Exercises in English Composition. *German. French.*

THIRD TERM—*Mineralogy.*—Dana's. Lectures and Practical Exercises. *Zoölogy.*—Lectures and Excursions. *Laboratory Practice.*—Quantitative Analysis, continued. Exercises in English Composition. *French*—continued.

SENIOR YEAR.

FIRST TERM—*Metallurgy. Geology.*—Dana's. Lectures and Recitations. *Zoölogy.*—Lectures. *Laboratory Practice.*—Volumetric and Organic Analysis. *Determinative Mineralogy.* Exercises in English Composition. *French*—continued.

SECOND AND THIRD TERMS—*Metallurgy.*—Lectures. *Agricultural Chemistry.*—Recitations and Lectures. *Geology.*—Dana's. *Laboratory Practice.*—Mineral Analysis and Assaying. *Determinative Mineralogy. French*—continued.

(b.) IN CIVIL ENGINEERING.

JUNIOR YEAR.

FIRST TERM—*Mathematics.*—Analytical Geometry of Three Dimensions. Church's Differential Calculus. Church's Descriptive Geometry, continued. *Surveying. Drawing.*—Mechanical Drawing. Exercises in English Composition. *French and German.*

SECOND TERM—*Mathematics.*—Differential and Integral Calculus. *Astronomy.*—Loomis's Astronomy, with practical problems. Exercises in English Composition. *French and German.*

THIRD TERM—*Mechanics.*—Peck's Elements. *Surveying.*—Topographical. Topographical sketching in the field. *Drawing.*—Binns' Second Course of Orthographic Projections. Linear Perspective. Isometrical and Topographical Drawing. Exercises in English Composition. *French.*

SENIOR YEAR.

FIRST TERM—*Field Engineering.*—Laying out curves. Location of line of Railroad, with calculations of excavation and embankment. Henck's Field Book for Railroad Engineers. *Stone Cutting*—with graphical problems. *Mechanics.*—Mechanics applied to Engineering. *Geology.*—Dana's. *Drawing.*—Architectural. Exercises in English Composition. *French.*

SECOND TERM—*Civil Engineering.*—Mahan's. Building Materials (Lectures). Strength of Materials. Bridge Construction. *Drawing.*—Mechanical. *French.*

THIRD TERM—*Civil Engineering.*—Bridge Construction, continued. Stability of Arches and Walls. *Dynamics.*—Principles of Mechanism. Steam Engine. *Hydraulics.*—Theory of Turbines and other Water Wheels. Neville's Hydraulics. *Drawing.*—Structural.

(c.) IN MECHANICAL ENGINEERING.

JUNIOR YEAR.

Pure and Applied Mathematics.—Geometry of Machinery. Analytical Geometry of Three Dimensions. Differential and Integral Calculus. *Mechanics.*—Analytical Mechanics. *Drawing.*—Binns' Orthographic Projections. Principles of Construction. Shading and Tinting, and drawing from Patterns. *Metallurgy.* Exercises in English Composition. *French and German.*

SENIOR YEAR.

Applied Mechanics.—Strength of Materials. Theory of Machines. Theory and Construction of the Steam Engine and other prime movers. Mill work. Examination of Machinery. Mechanical Construction. Use of tools. *Drawing.*—Drawing from actual Machines. Designs of Machines. Exercises in English Composition. *French. Metallurgy.*

(d.) IN AGRICULTURE.

JUNIOR YEAR.

FIRST TERM—*Theoretical and Organic Chemistry*—Lectures. *Experimental and Analytical Chemistry*—in their Agricultural applications. Laboratory practice. *French*—begun. *German*—continued.

SECOND TERM—*Agricultural Chemistry.*—Recitations. *Experimental Chemistry.*—Laboratory practice. *French and German*—continued. *Physical Geography.*—Lectures. *Zoölogy.*—Lectures.

THIRD TERM—*Agricultural Chemistry.*—Lectures. *Horticulture and Kitchen Gardening.*—Lectures. *Mineralogy.*—Lectures and Practical Exercises. *Zoölogy.*—Lectures. *Experimental Chemistry.*—Laboratory practice. *French*—continued. *Drawing.*—Free-hand practice. *Excursions.*—Botanical, Zoölogical, etc.

SENIOR YEAR.

FIRST TERM—*Agriculture.*—Cultivation of the Staple Crops of the Northern States. Lectures. *Agricultural Zoölogy.*—Origin and Natural History of Domestic Animals. Insects useful and injurious to Vegetation. Lectures. *Geology.*—Dana's Manual. *French*—continued. *Excursions.*—Agricultural, Zoölogical, Geological, etc.

SECOND TERM—*Agriculture.*—Stock-raising and principles of Breeding. Lectures. *English. Human Anatomy and Physiology.*—Lectures. *French*—continued.

THIRD TERM—*Rural Economy.*—History of Agriculture and Sketches of Husbandry in Foreign Countries. Adaptation of farming to soil, climate, market, and other conditions. Systems of Husbandry. Stock, sheep, grain, and mixed farming. Lectures. *Excursions.*—Agricultural, Geological, Zoölogical, and Botanical.

(e.) IN NATURAL HISTORY.

(Either Geology, Mineralogy, Zoölogy, or Botany may be made the principal study, some attention in each case being directed to the other three branches of Natural History.)

JUNIOR YEAR.

FIRST TERM—*Zoölogy.*—Daily Laboratory instruction; Zoölogical Excursions. *Botany.*—Gray's Text-Book; Use of the Microscope. *Chemistry.*—Theoretical and Organic Chemistry. *French*—begun. *German*—continued.

SECOND TERM—*Zoölogy and Palæontology.*—Laboratory practice. Lectures. *Botany.*—Lectures; Gray's Text-Book. *Physical Geography.*—Lectures and Recitations. *Chemistry.*—Laboratory practice. *French and German*—continued.

THIRD TERM—*Zoölogy and Palæontology.*—Laboratory practice. Lectures, Excursions (land and marine). *Botany.*—Excursions. Practical exercises. Gray's Manual. *Mineralogy.*—Dana's. Lectures. Practical exercises. *French*—continued. *Drawing.*—Free-hand practice.

SENIOR YEAR.

FIRST TERM—*Language.*—Whitney's Language and the Study of Language. *French.*—Selections. *Zoölogy and Palæontology.*—Laboratory Practice. Lectures. Excursions. *Botany.*—Excursions. Herbarium studies. *Geology.*—Dana's Manual. Excursions.

SECOND TERM.—*Zoölogy and Palæontology*—continued. *Botany.*—Herbarium studies. Botanical Literature. Essays in Descriptive Botany. *Geology.*—Dana's Manual. *Anatomy and Physiology.*—Academical Lectures. *French.*—Selections. *Whitney on Language*—continued.

THIRD TERM.—*Zoölogy, Botany, and Palæontology*—continued, with Excursions. *Photography.*—Practical instruction.

Besides the regular courses of lectures on structural and systematic Zoölogy and Botany, and on special subjects, students are taught to prepare, arrange, and identify collections, to make dissections, to pursue original investigations, and to describe Genera and Species in the language of science. For these purposes, large collections in Zoölogy and Palæontology belonging to the College are available, as are also the private botanical collections of Professor Eaton.

(f.) IN PREPARATION FOR MEDICAL STUDIES.

During the Junior year, the work of this course will be chiefly under the direction of the instructors in Chemistry. Especial attention will be given to qualitative and quantitative analysis, in their physiological and medical bearings; and to the preparation and study of the organic proximate elements. In the Senior year, the work will be chiefly under the direction of the Professors of Zoölogy and Botany. Attention will be paid in Zoölogy to comparative anatomy, reproduction, embryology, the laws of hereditary descent, and human parasites; and in Botany to a general knowledge of structural and physiological Botany, and to medicinal, food-producing, and poisonous plants.

(g.) IN STUDIES PREPARATORY TO MINING.

Young men desiring to become Mining Engineers, can pursue the regular course in Civil or Mechanical Engineering, and at its close can spend a fourth year in the study of metallurgy, mineralogy, etc.

(h.) IN SELECT STUDIES PREPARATORY TO OTHER HIGHER PURSUITS, TO BUSINESS, ETC.

JUNIOR YEAR.

FIRST TERM. — *German and Political Economy* — continued. *English.* Langland's Piers Plowman *French*—begun. Lectures and Exercises in Chemistry and Mineralogy. Lectures on the Physical Geography of Europe.

SECOND TERM.—*German, French*—continued. *English.*—Chaucer. *Astronomy.*—Loomis's Astronomy, with practical problems. *Modern History.*—Recitations and Lectures.

THIRD TERM.—*French*—continued. *English.*—Shakespeare. *Mechanics.*—Peck's Elements. *Botany and Zoölogy.*—Lectures and Excursions, and laboratory practice.

SENIOR YEAR.

LANGUAGE.—The study of French is continued through the year, and during the first two terms there are recitations in Whitney's Language and the Study of Language. In English, Shakespeare, Milton, Dryden, and Pope are the authors studied throughout the year, and in the order here named.

NATURAL SCIENCE.—The study of Geology is pursued by recitations, lectures, and excursions. Lectures are given in Rural Economy and the Principles of Agriculture, and also in Agricultural Chemistry. Botany is studied during the early part of the autumn term.

HISTORY, GEOGRAPHY, AND POLITICAL ECONOMY.—Lectures, Recitations, and Exercises will be continued through the year.

Exercises in English Composition are required during the entire course from all the students. The preparation of graduating theses is among the duties of the Senior Year.

Lectures on Military Science and Tactics are annually given. Instruction in Elocution is given to all who desire it the second term of Senior year.

Drawing.

The course in drawing extends through the three years. During the first term and half of the second term of Freshman year, the students practice free-hand drawing at the Art School building, under the direction of Professor Niemeyer, of the Yale School of the Fine Arts. After the completion of the course in free-hand drawing, instruction is given by Mr. F. R. Honey, during the second half of the year, in the elementary principles of instrumental drawing, embracing the whole of Binns' first course of orthographic projections, and Descriptive Geometry as far as warped surfaces. This course is obligatory upon all.

During the Junior and Senior years, instruction in drawing is obligatory only on the students in Civil and Mechanical Engineering. In the former year the system of instruction embraces Binns' second course in orthographic projections, isometric drawing, shades and shadows, tinting, perspective, and warped surfaces. By this method all the problems in Descriptive Geometry are required to be worked out on the drawing-board instead of the black-board. The course extends through the entire year, and is under the direction of Mr. Honey.

In Senior year, students are required to apply the principles of drawing already obtained to works of construction, under the general supervision of the professors of Civil and of Dynamic Engineering.

VII.

Methods of Instruction.

The instructions of this institution are given chiefly in small class rooms, by recitations or familiar lectures, illustrated by the apparatus at the command of the various teachers. In many studies weekly excursions are made for the purpose of collecting specimens and examining natural phenomena.

In Chemistry and Metallurgy the students work several hours daily in well appointed laboratories, under the direct superintendence of the instructors, and are guided through systematic course in quantitative and qualitative analysis, assaying, and the blow- determination of minerals and ores.

In Botany, during the summer of Junior year, exercises in analyzing and identifying plants occur two or three times a week, followed by practice in writing characters and descriptions of plants from living specimens. Students are shown also how to collect and preserve specimens for future use, several Natural Orders being especially indicated to each class for special work in collecting. In the autumn term of Senior year, the work of the summer is continued. Students are then expected to write generic as well as specific characters, and at the close of the term an essay on some one Natural Order will be required. During the second and third terms, a Herbarium of the indicated Natural Orders will be prepared and presented for examination at the end of the year.

In Zoölogy weekly excursions are made during the third term of Junior and first term of Senior year, in company with the instructors, for the purpose of observing the habits and making collections of marine, fresh-water, and terrestrial animals of all classes. Each student is required to prepare and present for examination a collection containing a specified number of species, and illustrating the various classes of animals. He must also be able to pass an examination upon his collection, at least to the extent of explaining the classes illustrated, and showing why particular specimens belong to their respective classes.

In Geology excursions are made for the purpose of examining geological phenomena, and seeing the rocks in place; and along with this there are frequent visits to the geological collections in company with the instructor, for the purpose of seeing larger series of fossils than can be exhibited in the class room.

In addition to the above, a course of lectures is given every winter by the professors of the school and others, on topics of popular interest.

VIII.

Tuition Charges.

The charge for tuition is $150 per year, payable $55 at the beginning of the first and of the second term, and $40 at the beginning of the third term. The special student of Chemistry has an additional charge of $70 per annum for chemicals and use of apparatus. He also supplies himself at his own expense with gas, flasks, crucibles, etc., the cost of which should not exceed $10 per term. An additional charge of $5 is annually made

to each student for the use of the College Reading Room and Gymnasium.

IX.

Church Sittings.

Free sittings for students in this department of Yale College are provided as follows:

In the Center Church (Cong.): Pews Nos. 36 and 42, in the North Gallery.

In Trinity Church (Episc.): Pews Nos. 175 and 177, in the North Gallery.

In the First Methodist Church: Pew No. 78, at the head of the West Aisle (below).

Any of the students may occupy a sitting in these slips. Those who prefer to pay for a sitting for a year, more or less, in the churches above mentioned, or in any other church of any denomination, will be aided on application to the Secretary of the School.

Sittings in the Gallery of the College Chapel are free as heretofore to the students of this department.

X.

Degrees.

Students of this department, on the recommendation of the Governing Board, are admitted by the Corporation of Yale College to the following degrees. They are thus conferred:

1. Bachelor of Philosophy: on those who complete any of the three-year courses of study, passing all the examinations in a satisfactory manner, and presenting a graduation thesis.

The fee for graduation as Bachelor of Philosophy, including the fee for Triennial Catalogues, Commencement Dinners, etc., is ten dollars; unless the person taking the degree is also an academical graduate, when it is but five dollars.

2. Civil Engineer and Dynamic Engineer: The requirements for these degrees are stated on pages 49 and 50.

3. Doctor of Philosophy: The requirements for this degree are stated on page 48.

XI.

Terms and Vacations.

The next academic year begins Thursday, September 10, 1874. The vacations correspond with those of the Academical Department, giving two weeks at Christmas, two weeks in the Spring, and eleven weeks in the Summer.

XII.

Announcement in Respect to State Students.

The scholarships established in this School in consequence of the bestowal upon it of the Congressional grants are designed to aid young men who are in need of pecuniary assistance in fitting themselves for agricultural and mechanical pursuits of life. All applicants must be citizens of Connecticut. In case there are more applicants than vacancies, candidates will be preferred who have lost a parent in the military or naval service of the United States, and next to these such as are most in need of pecuniary assistance: and the appointments will be distributed as far as practicable among the several counties in proportion to their population. The appointing Board for the current year, consisting of the Board of Visitors of the State and the Secretary of the School, will meet on June 23, 1874, and at about the same time in the year 1875, due notice of which will be given by publication in every county of the State. All applications should be made previous to that time. Blank forms for application will be sent, when requested, by Professor GEORGE J. BRUSH, Secretary of the Appointing Board.

XIII.

Anniversary.

The Anniversary of the School is held on Tuesday of the Commencement week in Yale College, June 23, 1874, when selections from the graduation theses are publicly read. The degrees are publicly conferred by the President and Fellows of Yale College on Commencement Day.

TENTH

ANNUAL REPORT

OF THE

SHEFFIELD SCIENTIFIC SCHOOL

OF

YALE COLLEGE.

1874–75.

PRINTED BY ORDER OF THE GENERAL ASSEMBLY.

NEW HAVEN:
TUTTLE, MOREHOUSE AND TAYLOR.
1875.

REPORT OF THE STATE BOARD OF VISITORS.

To the General Assembly of the State of Connecticut:

THE State Board of Visitors of the Sheffield Scientific School are happy to report, that though the standard of admission has been advanced, and is now high compared with other similar institutions, the whole number in attendance the present year (249) is larger than in any former year. Over one thousand students have been connected with it during the past ten years, and nearly three hundred have completed the regular course. It is one indication of the wide influence of this Department that seventy-five of its former students are now professors in science in American Colleges.

The Governing Board have generously added three gratuitous scholarships to the twenty-seven State scholarships allowed by law. These State scholarships have afforded to many sons of farmers and mechanics a free education which they could not otherwise have obtained. "Among them frequently are young men who have taken the first honors of the School, and who are now occupying positions of usefulness and trust."

In behalf of the Board,

CHARLES R. INGERSOLL,
Chairman.

BIRDSEY G. NORTHROP,
Secretary of the State Board of Education.

NEW HAVEN, May, 1875.

ANNUAL STATEMENT

OF THE

GOVERNING BOARD.

Ten years have now passed since the Sheffield Scientific School began to enjoy the benefit of the national grant for the promotion of technical and scientific education; and in presenting their tenth Annual Report the Governing Board feel a certain pride in referring to what has been accomplished during the first decade. The number of students is now nearly three times as great as when the first report was presented, and this too in spite of the fact that the requirements for admission have been steadily increased. The collections of various kinds have received great, and in some cases enormous, additions. The accommodations of the school, chiefly through the munificent liberality of Mr. Sheffield, have kept pace in great measure with its growth. Indeed, the chief danger which now threatens the institution is that its efficiency will be impaired by its very success; that the number of students will increase faster than the limited resources of the school can provide for them the best instruction. Still, with the experience of the past ten years before their eyes; with the recollection in their minds of the sympathy and aid from numerous quarters which they have received in times of doubt and difficulty; and with the knowledge that the reputation and efficiency of the school have never been so high as now, the Governing Board enter upon the second decade with the determination to keep it, as far as lies in their power, fully up to the ideal they have in view, and with the confidence that friends of scientific education will rise up to sustain them in the future as they have in the past.

The most important event of the year, as regards the progress of science in the institution of which the Sheffield Scientific School is a part, is the erection of the Peabody Museum of Natural History. Though all departments of the university will share in the benefits accruing from this, the Scientific School, on account of the

nature of its work, will be more materially assisted, not only by the increase of accommodations afforded by it, but by the opportunities for special study furnished by the vast collections and laboratories to be deposited within it. The building now in process of erection will, it is hoped, be completed during the present year, and full details in regard to it will be furnished in our next Annual Report.

No alterations of importance have taken place save the fitting up of room No. 13 in Sheffield Hall as a physiological laboratory; all the room in the analytical laboratory being imperatively required for its special work. The apartment is large enough for but few students, and is far from realizing what is actually needed; at the same time, in spite of its small size and limited accommodations, it has already been of good service.

National Aid to Schools of Science and Technology.

In accordance with a resolution adopted by the House of Representatives in Washington, D C., the following letter was sent in the latter part of February, 1874, to the President of this institution, and with it a schedule of inquiries in regard to the management and condition of the School.

WASHINGTON, D. C., February 18, 1874.

To Rev. NOAH PORTER, LL.D., *President of Sheffield Scientific School:*

SIR: On the second of the present month the House of Representatives unanimously adopted the following resolution:

"*Resolved*, That the Committee on Education and Labor is hereby instructed to inquire into the condition and management of the Agricultural and other Colleges which have received grants from the United States under the act of July 2, 1862, and the acts in addition thereto; also to inquire in regard to the investment and security of the funds of these institutions, and whether their management is in accordance with the Constitution and laws of the United States and the conditions of the aforesaid grants."

In the discharge of the duty thus imposed upon the Committee, we respectfully address to you the accompanying inquiries, and shall hope to receive your reply as promptly as your convenience and the preparation of the necessary information will permit.

These inquiries are addressed to you in no unfriendly spirit, but in the hope and belief that the large majority of the institutions contemplated by them have been honestly managed, and a large portion of them both honestly and wisely. We trust that the replies received will be so full, thorough, and candid as to prevent the necessity of any further measures to obtain the desired information.

This letter and the accompanying schedules will be forwarded, not only to institutions organized under the act of July 2, 1862,

but to others of similar character and object, in the belief that the officers of the latter class will take pleasure in replying to such of the inquiries as are pertinent to their circumstances and thus furnish the means of an instructive comparison.

Yours respectfully,

JAMES MONROE,
Chairman of the Com. on Education and Labor.

Many of the inquiries contained in the schedule it was not possible for the officers of the school to answer, there being no data in their possession upon which to found a satisfactory reply, but the following statement was transmitted, on the 16th of March, 1874, to the Committee on Education and Labor, and with the documents accompanying it, is believed to furnish all the information required in regard to the most essential points indicated by the resolution of the House.

Statement regarding the Sheffield Scientific School, in response to Inquiries made by the Committee on Education and Labor of the House of Representatives.

Hon. JAMES MONROE, *Chairman of the Committee on Education and Labor:*

Sir: The Sheffield Scientific School of Yale College was, by Act of the General Assembly of Connecticut, approved June 24, 1863, designated to be the recipient of such income as might be derived from the fund obtained from the sale of land-scrip donated to the State by the National Government in the Act of Congress, approved July 2, 1862.

The laws of the State [see document A, submitted herewith] placed the control of the scrip under the charge of the State Commissioner of the School Fund, to be sold by him, on terms to be previously approved by the Governor of the State, the avails to be invested in the manner prescribed by the Act of Congress, and the income of the fund to be semi-annually paid to the President and Fellows of Yale College, to be devoted exclusively to that department of Yale College known as the Sheffield Scientific School:—the said corporation agreeing to carry out the provisions of the Act of Congress, to make an annual report, and to devote one half of the income received to free scholarships for State students. Official information regarding the sale of the scrip and the funding of the amount received therefor can only be obtained from the State authorities. It is believed to have been sold in the summer of 1864 for seventy-five cents an acre, and that $135,000 was received from the 180,000 acres given to the State. This sum was invested in United States ten-forty gold-bearing 5 per cent. bonds, but by order of the General Assembly, in 1865, this investment was changed to Connecticut State bonds, in the same amount, bearing 6 per cent. currency interest.

benefi-

Yale College is believed to have been among the first institutions in the country to recognize the importance of the kind of education contemplated in the Act of Congress of July 2, 1862.

The Corporation of this College, in August, 1846, established a professorship of Agricultural Chemistry and of Vegetable and Animal Physiology, and at the same time they also established a professorship of Practical Chemistry, for the avowed purpose of "giving instruction to graduates and others not members of the undergraduate classes, in respect to the Application of Chemistry to Agriculture, to the Manufacturing Arts, to the exploration of the resources of the country and to other practical uses."

The following professorships have since been established:

1852, Civil Engineering.
1855, Metallurgy.
1856, Analytical Chemistry.
1859, Industrial Mechanics and Physics.
1860, French and German.
1863, Physical Geography.
1864, Agriculture.
1864, Botany.
1864, Zoology.
1865, Mining.
1866, Palæontology.
1870, Dynamic Engineering.
1871, Mineralogy.
1871, English.
1872, Political Economy.
1873, Mathematics.

Besides the incumbents of these chairs, the National Government in 1866 detailed an army officer to act as professor of Military Science, and a large number of lecturers and assistant instructors have from time to time been employed: for a detailed list of these reference is made to the Annual Reports, Nos. 1–8, herewith submitted.

In 1860 this school was provided with a commodious building, by the munificence of Joseph E. Sheffield, Esq., of New Haven, and the department was subsequently named, by the Corporation, the Sheffield Scientific School of Yale College. Although the school already provided almost everything contained in the Act of July, 1862, the authorities, in 1864, in anticipation of the reception of the income from the National Grant, enlarged its faculty by the appointment of special professors of Agriculture, of Botany and of Zoology, and made provision for instruction in Military Science, which latter has been regularly given up to the present time; and it is believed that in every particular they have conscientiously endeavored to carry out the intent of the Congressional Act.

The income from the National Grant is recognized as having been of the greatest service in making effective a plan already operating fairly, but needing further pecuniary aid to ensure a more complete success. The first year (1864–65), as the fund was invested in ten-forty bonds and gold was at a great premium, the income was larger than at any subsequent period: for the past seven years it has been uniformly $8,100 per annum. For an abstract of income and expenses see table on the next page. Our books are not kept in such a way as to give the data called for in your printed list of inquiries. A full and detailed account of the contributions to the Sheffield Scientific School may be found on

pp. 32–36 of the Seventh Annual Report, sent herewith, and lists of contributions to the collections of models and specimens are published in each Annual Report. The funds of this department are kept entirely distinct from those of other departments of the College.

	Income.				Expenses.			
Year.	National Land Grant.	Tuition Fees.	Other Sources.	Total Income.	Instruction.	Library, Apparat'us, Fuel, Gas, Labor, and Sundries.	Total Expenses.	Number Students
1864–65	$13,233.05	$3,267.00	$3,577.41	$20,077.46	$11,788.50	$6,241.06	$18,029.56	82
1865–66	7,551.56	7,041.47	3,728.99	18,522.02	17,925.00	5,826.76	23,751.96	89
1866–67	8,100.00	8,840.69	5,408.61	22,349.30	19,442.00	4,226.87	23,668.87	119
1867–68	8,100.00	9,157.22	5,193.67	22,450.89	19,590.00	4,445.62	24,035.62	120
1868–69	8,100.00	8,395.00	5,955.89	22,386.63	19,655.00	4,018.07	23,683.07	132
1869–70	8,100.00	8,140.00	23,634.05	39,874.05	17,810.00	15,441.50	33,251.50	139
1870–71	8,100.00	7,527.00	15,650.04	31,277.04	27,680.00	5,813.25	33,493.25	123
1871–72	8,100.00	15,305.77	20,683.93	44,089.70	32,180.00	5,911.11	38,091.11	146
1872–73	8,100.00	19,119.47	23,016.72	50,236.19	41,737.75	6,345.59	48,083.34	201
1873–74								242

State Inspection.—By an Act of the General Assembly of the State of Connecticut, a Board of Visitors is constituted whose duty it is to inspect the school, and see that the conditions of the Congressional Act are fulfilled, and annually to make a report to the Legislature, and also to examine and determine the claims of candidates for State Scholarships. The visits of the Board of Visitors have been at least twice each year, and their reports are herewith submitted. The number of the State Scholarships allowed by law is 27, but the authorities of the school have for several years permitted 30 to be admitted, in order to allow an equitable distribution of scholarships to each of the counties in the State.

Buildings and Apparatus.—The school now occupies two large buildings, the descriptions of which in full are to be found in the Second and Eighth Annual Reports. These buildings, with fittings and the lots of land upon which they stand, were the gifts of Joseph E. Sheffield, Esq., of New Haven, and cost about $215,000. The apparatus, models, and cabinets in Agriculture, Mechanics, Physics, Astronomy, Civil and Mechanical Engineering, Metallurgy, Mining, Zoology and Botany, with the technical library numbering 5,000 volumes, are valued at $75,000; but this does not include private libraries, collections, and cabinets of the professors, freely accessible to students, which may be valued at more than $40,000 additional. The members of this department have also free access to the library of the University, as well as to the Natural History and other collections and cabinets.

Instructors and other Officers.—The number of professors, lecturers, instructors and assistants for each year since the receipt of the income from the Congressional land grant is definitely stated in each Annual Report, and for the current year, the Report not

having yet been issued, the particulars may be found in the Programme sent herewith.

The instructors at present number 30 and with three exceptions have no connection with, and do not instruct in, any other department of the University. Their salaries are paid exclusively from the funds of this department. In this connection it may be well to remark that the President, Treasurer and Secretary of the University, whose names appear on the Programme, receive no pecuniary compensation from the funds of the school.

Students.—Over one thousand students have been connected with the school in its various sections, and some 280 have completed regular undergraduate courses connected with this department of College. The current year 242 are present: of these 37 are graduate students, 185 are in the undergraduate courses, and 20 are special students.

Section of Agriculture.—The school has always had students pursuing Agricultural studies, although the number taking the regular Agricultural course has been small. Nevertheless its teachers in Agriculture, from the foundation of this department, have wielded a powerful influence, not only in this State, but also throughout the whole country, in matters appertaining to both practical and scientific Agriculture. The names of the late Professors John P. Norton and John A. Porter, the first two occupants of the chair of Agricultural Chemistry, will be long gratefully remembered throughout New England and the Middle States for the earnest and successful endeavors they put forth to promote a sound agriculture. And the present incumbents of the chairs of Agriculture and Agricultural Chemistry are everywhere acknowledged as among the foremost men in their respective departments.

Professor Johnson has conducted researches in our laboratory of vast importance to agriculture, and his critical analyses of manures and his exposure of worthless or spurious fertilizers have been the means of saving hundreds of thousands of dollars to citizens of this State, besides, by the publication of this information, benefitting very materially the farmers of other sections of the country. Professor Johnson's volumes entitled "How Crops Grow" and "How Crops Feed" have been introduced as textbooks in many Agricultural Colleges, and other institutions where Scientific Agriculture is taught. They have not only been widely circulated in the United States, but these works have also been republished in England, and, with a highly commendatory introduction by Baron von Liebig, have been translated into German by his son, Herman von Liebig, for the benefit of German agriculturists. During the past year these books have been translated into Russian and published in St. Petersburg, for the improvement of the farmers of Russia. We have no farm.

Section of Civil and Mechanical Engineering.—In the chairs of Civil and Mechanical Engineering, the school has had the good fortune to secure as professors two eminent graduates of the

West Point Military Academy, and under these gentlemen the institution has trained a large number of men who are occupying important positions as engineers in the survey, construction and care of railways and other public works, mines and manufacturing establishments. Draughting, designing and practical experience with instruments in the field are among the requirements in this course. We have no machine-shop for students.

Chemistry, Mineralogy and Metallurgy.—In the section of practical Chemistry, Geology, Mineralogy and Metallurgy the school has from its earliest establishment furnished analytical chemists, assayers, metallurgists, mineralogists, and geologists, who have done good service in their several callings.

Besides these the school has contributed trained men to the U. S. Coast Survey, the Hydrographic Bureau, the National Observatory, and geologists and explorers and topographers for the Government service in connection with the U. S. Engineering Department, among whom may be mentioned Clarence King, Geologist in charge of the 40th Parallel Geological and Topographical Survey, who with other members of his corps graduated here.

But perhaps the most signal service which the Sheffield Scientific School may justly claim, is the education, in whole or in part, of 75 professors in science, who are occupying positions of responsibility in connection with colleges in different parts of our land.

Special Students.—In addition to the regular courses, the advantages of the school have always been open to persons not candidates for degrees or desiring to take a complete course, but wishing to spend a longer or shorter time in the study of some particular subject. It has thus afforded an opportunity for students, specialists, and others engaged in practical affairs to perfect themselves in some branch of knowledge essential to further progress. A list of these special students for each year can be found in the programme appended to the Annual Report.

While affording a "liberal and practical education" in many different kinds of technical science, it has, however, been kept steadily in view as the leading object of this department to inculcate a love of science for its own sake, thereby to foster original research and extend the bounds of knowledge, as it is firmly believed that by this method the resources of the country will be most rapidly developed, the mechanical arts advanced and perfected, and the methods and appliances of agriculture improved.

It has been hoped and expected that no small proportion of those trained here would devote themselves to scientific investigation, and by their knowledge and skill prevent the sinking of capital in worthless schemes, expose fraudulent and ignorant efforts to deceive the public, and by the application of the principles of science so improve the processes prevailing in Agriculture and the Mechanic Arts as to benefit the whole country by benefitting the productive and laboring classes. In this hope we have not been disappointed.

In concluding this statement, the authorities desire to express to the Honorable Committee their very grateful acknowledgments of the essential service which the income from the National Land Grant has rendered to this institution. While struggling to accomplish the very objects included in the Act of Congress, this help, proffered at a most critical period in our history, brought certainty of success where there had been doubt and rendered our plan immediately effective. This gift has also been the means of affording to many persons in this State, from the farm and the shop, a free education, which without the Government aid they never could have obtained. Among these are young men who have frequently taken the first honors of the school and are now occupying positions of usefulness and trust.

It has been found impracticable to respond in detail to the questions contained in the printed list of inquiries, and the foregoing statement is respectfully offered as being a full exhibit in regard to all points where the National Government has relations with us.

If further information regarding the character, organization and workings of the Sheffield Scientific School is desired, it will give us pleasure to send one or more of our officers to appear before you personally at such time as you may designate.

(Signed) NOAH PORTER,
President of Yale College,
For the Governing Board of the Sheffield Scientific School.

The report of the Committee was made to the House of Representatives on the 13th of January, 1875, and the facts elicited may be regarded as on the whole amply proving the wisdom of the policy which led to the enactment of the Act of July 2, 1862.

Agricultural Experiment Stations.

The subject of agricultural experiment stations having become one of great interest to the farming population of the State, and having already been brought twice before the Legislature for consideration, it was deemed expedient by the Governing Board to bring together and put into accessible form the facts necessary for the proper consideration of this question. At their request, one of their number, Prof. S. W. Johnson, accordingly prepared a full report as to the extent to which these experimental stations had been established in Europe, the objects which they had set out to accomplish, the benefit they had conferred upon agricultural industry, and in general terms the success or failure which had attended the work they had been designed to do. The details of the information thus collected Professor Johnson gave in one of the lectures of the Mechanics' Course, delivered during the past winter, and the same facts essentially have been

repeated in lectures subsequently delivered by him in various places in the State. The following full text of Professor Johnson's report was submitted to the Governing Board, and ordered by them to be printed in their annual statement.

The Agricultural Experiment Stations of Europe.

FARMING is a perpetual trying of experiments with soils, manure and crops, with cattle and cattle food, with milk, butter and cheese, with plows, harrows, and harvesters: with an almost endless list of things. The most successful farmers—those who get the most out of their land, their cattle, their crops, their fertilizers, their implements, and their labor—are those who experiment themselves most industriously, most skillfully, and most intelligently, and who take the fullest advantage of the experiments of others. The best agriculture is that which, in old countries, on worn and intractable soils, has learned by long-continued and varied experiment to make the gain of farming so sure, that capitalists as willingly loan money to invest in farm improvements as they put it into bank or railroad stock.

To take away from our agriculture what has been learned by toilsome and costly experiment would put us all back into the dark ages, for it would annihilate a thousand industries by cutting off supplies of the raw materials they work up; it would stop our railway trains, and lay up our ships at the dock, for there would be no grain, no cotton, no fruits to transport. The country would stagnate for want of knowledge how to keep its men and women employed; the land would grow up to weeds and woods for want of implements to till it, and for want of seeds to plant. A few winters would starve our cattle, a few years would bring famine to ourselves. The cities, which have their roots in the country, would be paralyzed in every industry, in all their traffic, in all their commerce. The North would be depopulated by starvation or by emigration to snowless and frostless latitudes, and only a few hunters in winter, or herdsmen in summer, would break the solitudes of a New England desolation.

Our wealth, our enterprise, our intelligence, and our very virtue depend in large degree upon our agriculture; and our agriculture is the result of experience, and therefore depends mainly upon experiment. Agricultural experiment then, it cannot be denied, is an exceedingly weighty matter.

But as agriculture has grown in the past from small beginnings and by slow degrees until it has subdued the forests and dried up

the morasses of nearly all Europe and much of North America, and has raised our savage and plundering German and Anglo-Saxon ancestry to such habit of doing and having, that their posterity, by sheer inheritance of character and possessions, now comprise the foremost nations of the world,—so agriculture must go on to grow, winning more acreage from forest and swamp, building more railroads and steamships, more cities and manufactories, and employing an ever-increasing force of men and women, horses, waterwheels, and engines to do its traffic, turn its useful raw products into more useful fabrics and foods, or to supply its incessant demand for more tools, machines, and fertilizers.

Our soil is a mine of infinitely more riches than all the gold veins or placers of California and Colorado. Out of it the farmer digs our food and our clothes, and that mainly sums up the wealth of most of us. This riches of the soil may be easily squandered, and much of it now is from mere ignorance as good as thrown away. It may be restored also. Unlike metallic ore, which once dug out and skillfully smelted is forever worthless, the soil has a productive power of unlimited duration. The agencies that made soil from rock in the ages past are perpetually at work making new soil from the rock of to-day, as well as developing new fertility in the ancient soil. Man "by searching" has found out various means to accelerate and intensify this restoration and elaboration of fertility, and that people among whom the quest of better, cheaper, and more energetic means of heightening the productive power of the soil, and of best economizing that already at disposal, has been most successfully prosecuted, is the people that will lead in the march of civilization, and will impress its language, its manners, and its morals on the world.

Our agriculture has two very prominent wants. The one is a more universal acquaintance with and practice of what has already been learned, and the other is the learning of many things now unknown, which we feel important to understand—the settlement of much discussed questions that vex and baffle us in laying our plans, and embarrass our practice—the discovery of new facts that shall enlarge and improve our systems of farming. Every farmer remembers that his successes have been reached by a series of discoveries on his part. He can remember when he followed this and that practice, which he has come to see are defective and injurious, and therefore has abandoned—that he was once ignorant of most useful operations, resources, and methods, which, one by one, have been revealed to him, either by conversation, reading,

visiting some neighbor, near or remote, or by reflection and observation on his own premises.

Every New England farmer who maintains or increases the productiveness of his land under the changed circumstances of recent years has done it by using knowledge which his forefathers did not possess or did not use, and no such farmer would willingly part with the knowledge thus gained. He would not part with it because there is advantage in it, money in it. He would not part with it because it has been a pleasure to acquire, and is a pleasure to possess and to communicate, and because he feels that he himself has grown and ripened by the gain of this knowledge. It has become a part of himself, and in its assimilation he has become richer and stronger, and is happy in a greater mastery over nature, as well as in a consciousness of being abreast of the time and its opportunities.

The successful farmer is also he who most keenly feels the need of more knowledge. He has had his eyes most widely opened to the defects and insufficiency of his farming. He appreciates most keenly that, while the least cost of a crop or of an animal's keep amounts to a certain sum—whether corn and cow be good or bad—the profit lies mainly in every kernel of grain or drop of milk he can produce *as increase* above the ordinary yield. To get an increase becomes his unceasing endeavor. He tries this method and that, varies the tillage and the treatment of the crop, varies the rations and increases the care of his cows, proving all things and holding fast to that which experiment shows to be good. But with his best efforts he feels that there are blanks in his knowledge that he cannot fill. He tries a practice most highly recommended, and can get no profit of it, then another with like result, and often finds the gains of his successful trials fully offset by the costs and losses of his failures. He does not lose faith in this plan of getting knowledge, but he learns that he cannot carry out all his good ideas, cannot make all the trials he would like, and has to submit to uncertainty and disappointment. He is more sobered than inspirited by some of his ventures, and if he does not settle down in "the good old way," he inclines more thereto, and feels a more charitable sympathy for those who let their neighbors try experiments, and even for those who get on by saving and by "scrimping," rather than by learning.

Recent years have brought a marvelous increase of knowledge into the world of affairs, and have strangely intensified the search for knowledge, as well as multiplied and energized the means of it.

covery. The methods and the fruits of intellectual investigation, the systematic hunting down of things hidden from the common gaze, and the game thus captured, are what we call science. Science is the peculiar pride and glory of our century, for, although its seeds struck root in the old centers of Hindoo, Egyptian, Greek, Roman, and Arabian civilization, it has grown, like the Century Plant, with wearisome slowness, until, almost in our time, it has shot out its flowering stem, and is now at once unfolding a myriad blossoms and hanging full of precious fruits.

Of these benefits agriculture has had a fair share, and the results are like the transformations of magic.

It is a little more than a century ago that the wagon, the plow, and the harrow were almost the only machines used in the field processes of agriculture, and these were of rude and inefficient construction. There were almost no other implements then known for making the labor of four-footed animals of avail in farming operations. Then seeds were sown, crops weeded and tilled, harvests gathered, grain threshed and dressed almost exclusively by hard human toil.

So fixed had become the habits of the farm through long centuries of unvaried drudgery, that when Jethro Tull invented his seed-drill and horse-hoeing implements he could hardly make way for them, even by showing that they withstood the crucial test of use. It took many years to bring horse-husbandry to the level of practice, and practice to the level of horse-husbandry. But to-day we prepare the ground, sow the seed, till the plant in all stages of its growth, cut, spread, and gather the harvest, lift it upon the wagon, and lift it again into the barn loft, thresh, winnow, and bag it all by machines impelled by horse power, and only requiring a little skilled guidance and some ordinary attendance for full success.

A quotation from Eliot's "Fifth Essay on Field Husbandry," published in 1754, well illustrates by what stages and influences the machines for utilizing horse power on the farm have been gradually simplified, perfected, and cheapened so as to admit of universal use. The quotation, for which I am indebted to Professor Brewer, is as follows:

"Mr. Tull's wheat drill is a wonderful invention, but being the first invented of that kind, no wonder if it be intricate, as indeed it is, and consists of more Wheels and other Parts than there is really any Need of. This I was very sensible of all along, but

knew not how to mend it. Therefore I applied myself to the Reverend Mr. *Clap*, President of *Yale* Colledge, and desired him, for the regard he had for the Publick and to me, that he would apply his mathematical Learning and mechanical Genius in that Affair; which he did to so good Purpose that this new modelled Drill can be made for the fourth Part of what Mr. Tull's will cost."

A century ago the hard labor of a man could cut, rake and bind, thresh, and clean at the rate of but seven bushels of wheat per day, and there was no other practicable way known of doing the greater part of this necessary work. Now, a day's work of a man, attending our improved machines, can harvest and prepare for market fifty bushels.

Half a century ago two men and five horses, working in the most approved manner of those days, could comfortably thresh, and clean, and get away the straw of 108 bushels of wheat in one week, or eighteen bushels per day. Last year, in California, human labor, in attendance on a steam thresher and cleaner, could travel from farm to farm and dress and bag wheat at the average rate of 110 bushels per man per day, and in full work could finish 165 bushels per man per day. Such saving of precious time at the critical periods of planting and harvest, and such release of human energy from lower to higher uses, is the result of improvements in the mechanics of the farm.

Chemistry, but a hundred years old, as we might say, has escaped within twenty-five years from the apothecary shop and the dye-house, and gone to work in the fields without disguise. She has always worked there, but anciently did her good deeds for the farmer in a fairy dress, and remained altogether invisible to the common eye.

About the middle of the last century, a lighthouse, known as the Dunston Pillar, was built on the Lincoln Heath, in Lincolnshire, England. It was erected to guide travelers over a trackless, barren waste, a very desert, almost in the heart of England; and long it served its useful purpose. The pillar, no longer a lighthouse, now stands in the midst of a fertile and rich farming region, where all the land is in high cultivation. For twenty-five years no barren heath has been visible, even from its top. Superphosphate of lime, a chemical invention, first applied to land by the British chemist Murray, and brought to the notice of reading farmers by Baron Liebig, has been the chief means through which this great change was effected. Superphosphate over great stretches of English soil makes, or once made, the turnip crop. Turnips there

support sheep, and with sheep the English farmer knows how to get rich on the poorest light lands.

Liebig, in 1840, called attention to the chemical composition of the guano of Peru. That very year a few casks were imported into England as an experiment. The next year 2,000 tons were brought, and in sixteen years its aggregated sales in Great Britain amounted to $100,000,000. Now Britain, Germany, France, and our seaboard States cannot get enough of it.

Our State of Georgia is officially estimated to expend $10,000,000 annually in the purchase of fertilizers, and single towns in this State lay out thirty to fifty thousand dollars for guano, phosphates, etc., besides using large quantities of home supplies.

Chemistry has taught agriculture how to utilize the refuse of slaughter houses, and fisheries; the bones, the flesh, the blood, which but a few years ago were a waste, a nuisance, and a peril to the public health. It has found vast mines of fossil phosphates in England, Canada, Norway, Spain, France, Germany, South Carolina, Russia, and, but a few weeks ago, in Austria: and has shown how they may be quickly and profitably converted into a precious fertilizer.

Chemistry, by discovering and accurately defining the food-elements of vegetable growth, and by revealing their sources and realizing the means of making them cheaply available to the farmer, has triumphantly overcome one of the previously insuperable obstacles to the development of national wealth.

Agricultural exports impoverish and ultimately exhaust any soil. Only a few favored regions are regularly fertilized by the exceptional arrangements of nature. The Nile valley, in Egypt, is annually top-dressed with the richest and finest *débris* of the tropical jungles and forests of half Eastern Africa, poured over all her acres by a never-failing inundation, and with diligent irrigation is as fertile to-day as it was two thousand years ago.

But Italy, Germany, France, Britain, and the United States, have seen, or are seeing, the productiveness of thousands of their fields decline to a profitless minimum, until lands once beautiful with harvests are desolate and abandoned. But the artificial barrenness of exhaustion, like the natural barrenness of the heath, or the sand-down, yields to the touch of science; and in all the older countries I have named, the work of reclamation is in full progress, and barring some great calamity of politics or nature, we are

confident that the producing power of their soil will never again be less than now, but will increase many fold in the future, until they become gardens in all their breadth and to the very hill tops.

Many pages might be occupied in recounting the gain which agriculture, like all our industries, has received at the hand of science. It is but a few years since agriculture has been taught in universities and in special agricultural schools, because it is but recently that there has been anything to teach beyond the routine of manual practice that can be learned on any well managed farm. But now the Professor of Agriculture, the Professor of Agricultural Chemistry, the Professor of Vegetable Physiology, of Animal Physiology, find superabundant occupation in acquiring, systematizing, and communicating the facts and truths that constitute agricultural science. If in this country their labors in communicating are not excessive, it is because of special circumstances which will soon be changed.

Much of the advantage which agriculture has derived from science has come to it in the same way that President Clap cheapened the seed drill, viz: "out of regard for the Publick." It was thus that Lawyer Tull, travelling for his health among the vineyards of France, and reflecting on the methods and results of vine culture, conceived those ideas of horse-husbandry, which he afterwards became a landholder for the sake of reducing to practice.

It was thus that James Smith of Deanston, Scotland, a manufacturer intent on bettering the life of his workmen, and substituting wholesome gardening and cow-keeping for the guzzling of beer and other village immoralities, learned those lessons in the thorough drainage and subsoil-plowing of clay lands that have added millions to the wealth and resources of British farms.

It was thus that Theodore de Saussure, of Geneva, Humphrey Davy, of London, and Justus Liebig, of Giessen, initiated those studies in Agricultural Chemistry and Physiology, which have added, and are to add, other millions to the wealth and resources of Europe and this country.

The mowing machine was invented and brought almost to perfection on the glebe of an English parsonage, by an English clergyman, Rev. Patrick Bell. The cotton gin, which raised a barely useful plant to a sudden commercial and manufacturing preëminence, was the unrewarded gift of a New Haven school-master, Eli Whitney, to the country and the world.

Within a few years farmers, seeing the advantages to be derived from uniting the resources of science with those of practice, in a systematic attempt to improve the methods, operations, and results of agriculture, have begun the establishment of the so-called Agricultural Experiment Stations.

The object of these stations is to make a regular business of discovery for the use of farming. To this end, farmers have formed associations, contributed land, buildings, cattle, labor, money and whatever seemed needful or desirable to prosecute this business. They have undertaken it as a means of making money, a means of saving money. They have wanted to know how to save and use manure, in order to make good crops cheaply; how to save and use cattle food in order to get good beef, wool, and milk cheaply. Aware that accurate and full knowledge of these matters could only be obtained by accurate and numerous experiments, they determined to have the experiments. Feeling that on their own farms the work of experimenting was costly, interfered with the regular business of the place, could not be properly carried on for want of skilled hands, and could not be suitably laid out for want of skilled heads, they united together to bring all these requisites into one focus, so that instead of having to be content with the gratuitous and accidental drippings from the science of the universities and schools, they might have their own well-spring of information, under their own control, and for their own purposes, purely.

They recognized the fact that science had developed the use of many valuable instruments of discovery—the thermometer, the microscope, the balance—that chemical analysis and the art of chemical investigation, which had given to the world phosphorus, superphosphate, chloroform, petroleum, photography, electroplating, and were to give chloral, the superb dyes of coal tar, and an endless list of benefactions, were veritable engines of progress—and they determined to make full avail of them. They saw, too, that the farm was the place where these might most effectually be put to doing farm work, and therefore, in the year 1852, a company of Saxon farmers, constituting the Leipzig Agricultural Society, opened the first *Farmers' Station for Agricultural Experiment*, at the little village of Mœckern, near the city of Leipzig. The society already owned there a small farm, with farm house, barns, and some improved stock and implements. They engaged Dr. Emil Wolff, a young scientist of promise, to take charge, and Mr. Baehr, the manager of the farm, was instructed to superintend

all the practical detail of experiments. Two or three rooms were fitted up as a chemical laboratory, a small glass house was built for vegetation experiments, an assistant chemist was secured, and the Experiment Station was an accomplished fact.

This was not, indeed, the first association of farmers for scientific investigations in behalf of agriculture, nor was it the first instance of science taking up her abode on the farm. Scotland had her "Agricultural Chemistry Association," that, established for a period of five years, began its operations in 1843, and in 1848 was practically merged in the "Highland and Agricultural Society."

France had, so far back as 1835, in the neighborhood of Strasburg, an experiment station on the farm of Boussingault, who was Professor of Rural Economy in the Conservatory of Arts, in Paris. Both in the laboratory at Paris, and on his estate of Bechelbronn, Boussingault has for forty years carried on a series of most valuable researches, whether considered from the point of view of practice or of science.

When, in answer to the menace of Napoleon, the battalions of Germany swarmed over the fields of Alsace, it was well understood by Bismarck and Moltke that Jean Baptiste Boussingault was not merely a Frenchman, but was also a citizen of the world, a benefactor of every Prussian, Saxon and Bavarian landlord and peasant, and one who held highest rank and had done longest service among the priests and interpreters of nature. Bechelbronn was to them as holy ground, and was sacredly guarded from all molestation.

But Mœckern was the first station where farmers themselves brought science to their own farm to aid them in their own farming. The example there given was so brilliant and solid that within two years another Saxon society, in the town of Chemnitz, set up a second station, and of the twenty-two years that have since elapsed, 1867 is the only one which has failed to witness the founding of one or more similar institutions in Germany or the neighboring countries. The experiment station shortly came to be regarded not as a costly embellishment, or an agricultural luxury, in which universities or wealthy gentlemen might harmlessly indulge, but as a most remunerative and most necessary agency for the use as well as for the education of farmers.

The rate at which the idea of the agricultural experiment station fructified in continental Europe may be gathered from the following statement of the number of stations in existence there at the expiration of each period of five years that has passed since

the establishment of the station at Mœckern: In 1852, one; in 1857, eleven; in 1862, nineteen; in 1867, thirty; in 1872, sixty-two; in 1875, seventy. There are thus seventy of these experiment stations in Europe, each employing from one to five investigators, trained in the great modern schools of chemistry and physiology.

Some thirteen of these stations are chiefly devoted to the study of cattle feeding, as at Weende, Proskau, and Milan; some twenty-five to experiments on the conditions of vegetable growth, and the action of manures, as at Dahme, and Ida-Marienhütte; some to tobacco and grape culture, as at Carlsruhe; some to grape culture and wine making, as at Wiesbaden and Padua. The station at Udine is devoted to studies in silk production; those at Stockholm and Lodi to milk industry. Thirty stations are largely occupied with analyses of commercial manures. Eighteen stations test the purity and vitality of seeds. Most of the stations, however, combine several of these objects in their operations.

During the years 1852 to 1857 the Mœckern station published five reports of the experiments and researches there conducted, making together a most valuable volume of 574 octavo pages. Many others of the German, Austrian and Italian stations have issued similar reports in pamphlet or book form.

In 1859 began the publication, in Germany, of a special organ of the workers in what had thus grown to be a national enterprise. This journal, entitled *Versuchs-Stationen*, issued in bi-monthly parts, continues to this day. For the first years of its existence it formed a closely printed annual volume of 240 to 360 pages. In 1864 it thickened to nearly 500 pages, and still maintains that dimensions.

In 1863 the number of chemists and investigators connected with the experiment stations and agricultural schools had become sufficient to warrant an annual convention for discussion and exchange of views, and for ten years this general conference of the agricultural explorers of Germany has been only once interrupted, and that by nothing less than the great war of 1866.

Previous to 1870 Italy had no institutions of this kind. In that year a commissioner was sent by the government to inquire into the workings of the German experiment stations. His favorable report led to their immediate establishment, and four were at once organized; nine were in operation in 1873, and now thirteen are in working order.

In the summer of 1874 an International Agricultural Exhibition was held at the great German port of Bremen. Of this exhibition

the 10th section was exclusively devoted to the experiment station. Thirteen experiment stations and Agricultural Colleges were represented, and a very fair display was made of the various instruments, apparatus and arrangements employed in the stations for the scientific study of agriculture, as well as printed reports and tables, drawings, and diagrams illustrative of the methods and results of investigation. The experiment stations having unitedly declined to receive a money premium, had conferred on them the grand prize of honor of the Senate of the city of Bremen.

But what have the experiment stations accomplished? The farmer's work consists first in converting soil and manures into crops, second in converting crops into beef, mutton, pork, milk, wool, labor and manure. In Europe the farmer often manufactures some of his crops into starch, sugar, wine, alcohol, &c.

The very earliest investigations in the Mœckern station were upon "The feeding of sheep to ascertain the best 'sustaining rations,'" i. e., the best combination of food for simply maintaining the weight and condition of a mature sheep, and upon "The dependency of plants on the atmosphere, and on mineral salts and salts of ammonia." These fundamental questions of agricultural science had been much discussed in the universities and much was known about them, but they were far from a satisfactory solution. On the farms too there prevailed the greatest diversity of opinion as to what constituted a sustaining ration for any given animal, and also as to the extent to which crops depend upon the atmosphere.

Without stopping now to review the state of agricultural doctrine and practice, as it was twenty-five years ago in Germany, or to trace in detail the steps of progress since traversed, I will state briefly some of the substantial advantages that have been gained as the immediate outcome of the efforts of the experiment stations.

1*st.* In respect to the food of plants, it has been settled that potash, lime, magnesia, iron, phosphoric acid, and sulphuric acid must be furnished to all agricultural plants through their roots and by the soil, in order to their growth. It has also been shown that soda, silica, and chlorine are not needful for the early growth of grain crops, but that chlorine is essential for the perfection of the seed, and that silica is probably necessary to uniform blossoming and ripening. It is further proved that water must enter crops through their roots; that carbon, which constitutes more than half their weight, is superabundantly furnished by the air; that air and

water together yield the materials out of which fully ninety to ninety-eight per cent. of crops is built up; and that the soil has to give for their nourishment but the two to eight per cent. of mineral matters which remain as ashes when they are burned, and the one-half to two per cent. of nitrogen which they also contain. It is likewise definitely settled that nitrates in the soil are the chief natural source of nitrogen, while the ammonia of manures, as well as a variety of substances containing nitrogen, and found in urine or formed in the decay of dead animals, likewise supply vegetation with nitrogen.

The experiment stations have further ascertained, by a multitude of trials, what quantities and proportions of all these elements are needful to produce any given crop, and to what extent they are removed from the soil. On the other hand, it has been determined what kinds of plant food, and what quantities, are contained in the long list of manures and fertilizers, in all kinds of dung, urine, ashes, salts, guanos, phosphates, manufacturing refuse, etc., etc. The remarkable quality of the soil to sift, as it were, some of the most valuable because most costly fertilizing elements out of manures, retaining them in a form not easily or not largely removed by rain, and yet accessible to the roots of plants—the so-called absorbent or fixing power of soils—has also been elaborately studied. We have thus a pretty complete knowledge of what a crop requires for its growth, what it carries off from the land, what is returned in straw or tops, and where we may look for the most effectual and cheapest restoration of the materials thus removed. The well-instructed farmer is thereby put in possession of the data for keeping accounts between his soil and his crops, so that he can estimate with accuracy what the soil itself can be relied upon to contribute yearly towards their production, and what must be supplied yearly or during each rotation, by means of manures, in order to maintain, to develop, or to increase the fertility of the land.

Dr. Wolff, who conducted the scientific work in the Mœckern station at its beginning, is the author of a valuable series of tables, which are published in a Farmers' Almanac, in Germany, and are largely employed in this kind of reckoning. One of these tables gives the quantities of water, nitrogen, potash, lime, phosphoric acid, etc., in 1,000 parts of all the plants and parts of plants which are encountered in German agriculture, including fifteen kinds of hay, twenty of green forage, nine of roots, eleven of leaves and tops of root crops, twenty-nine of meal, bran, oil cake and other

manufactured products and by-products, sixteen sorts of straw, eleven varieties of chaff, twelve kinds of commercial plants, such as flax, hops, grapes, etc., fourteen of litter, like forest leaves, ferns, flags, sedge, etc., thirty-four varieties of grains and seeds, and seventeen kinds of animal matters, milk, cheese, blood, meat, wool, etc., making a total of 188 farm products.

Another table gives the composition, in 1,000 parts, of twenty-four varieties of stable and domestic manures, forty-seven kinds of guanos and mineral fertilizers, ten sorts of superphosphates, designated by the material from which they are made, and twelve grades of potash salts.

A third table informs us what 1,000 pounds of barley and fifteen pounds of hops are separated into in the beer manufacture, how many pounds of spirits, grains, spent hops, etc., result, and how many pounds of water, nitrogen, potash, lime, phosphoric acid, etc., exist in each and all of these materials. This table also gives the corresponding products and their composition in case of the manufactures of yeast, of wheat flour, of cheese, of beet sugar, and of flax.

The experiment stations have, by their numerous exact trials, furnished us with rules for calculating from the rations of the animals the composition as well as the quantity of stable manure which is furnished by the different classes of live stock.

By aid of the facts thus made accessible to him, the German farmer can and does economize the resources of his soil, of his manure yard, and of the fertilizer market to a degree that was simply impossible twenty years ago. He can acquire as clear an idea of the state of his soil as to crop-producing capacity, as to what it needs and what it is already possessed of, as he has of his bank account. He can learn whether any course of cropping actually carried out in the past or proposed for the future has removed, or will remove, more or less potash, phosphoric acid, sulphuric acid, etc., from the field than the field has received in manures, or will be likely to yield without disturbing the equilibrium of its stores of plant food.

This cannot be done from these tables alone by any one who is merely able to read them or to reckon by rule of three, any more than the nautical almanac will enable the ship's cook to find latitude and longitude; but the tables give to the farmer who is moderately instructed in the now received doctrines of agriculture, in the matter of crop-production, the data for finding where he stands in relation to his soil and his crop, just as the tables for

latitude and longitude serve the master of a vessel, who can identify a star and use a sextant to find his position at sea.

We labor here not only under the disadvantage which the educated German farmer has in a good degree overcome, by the use of the permanently valuable facts laid down in these tables, but we likewise suffer from the circumstance, that when we would try to sail by "dead reckoning," there is so much ignorant misrepresentation, or willful fraud practised upon us in throwing the log or by hanging out false lights, that we are in continual uncertainty as to our course.

If we gather from the best consideration of the evidence at our hands that a field needs potash or nitrogen, or phosphoric acid, we find plenty of parties willing to sell us these things, but we also find that we cannot depend upon getting the worth of our money. Our markets are full of "superphosphates," "poudrettes," "tobacco-growers," "bone dust," "bone flour," "ground bone," of "bone meal," "pure," "best," "finest," "celebrated," "rotted," and "dissolved," of "meat scraps," "blood and bone fertilizers," "animal dust," &c., &c., some good, some bad, and in many cases the good appearing to be on the way to the bad. Many of our farmers have laid out their money for some of these things and know that they were cheated, by not getting what was promised and what they supposed they were securing. Some have been bitten so badly that they purchase nothing, unless it is ashes, plaster, bone, fish scrap or something which they can judge of by its looks. Some again have purchased these very fertilizers whose value they believed they could estimate by inspection, only to learn when too late that they had been ingeniously deceived, and that the supposed "bone" contained twenty to fifty per cent. of water, oyster shells, plaster or niter cake, which had no value for their farming.

The German farmers have had the same experience. It is just about twenty five years since in Germany, as here, the trade in superphosphates, guano and similar commercial fertilizers began. The same stupendous frauds by adulteration and dilution of good things were practiced there as they have been and, we have great reason to fear, still are carried on here. But the experiment station has perfectly cured and rooted out these evils in all the districts where it has been established and appreciated. The experiment station there is prepared to furnish the farmers at small cost with an analysis of any fertilizer he proposes to buy. The farmers avail themselves of this aid. They will buy no fertilizer without

an exact statement of its composition, and they buy with the understanding that any deficiencies in the stipulated amount of fertilizing matters shall be made good or deducted from the payment. Under such circumstances manufacturers can sell nothing that is not substantially what it claims to be. A further result of this system is that low-grade fertilizers are little sought, and those makers who can supply the best article, of uniform quality and at the lowest rates, have the business. With large sales the dealers prosper, while the consumers are satisfied with their purchases, and instead of trying to see how they can get along with small use of purchased fertilizers, they are studying how to use the greatest quantities to advantage. The fertilizer market in Saxony and Prussia, where the experiment station has the universal sanction and confidence of the farmers, is just as settled and satisfactory as any branch of trade, and the farmers there buy superphosphate, guano, potash salts, etc., with as much security of fair dealing as we can feel in the purchase of sugar or nails.

In the second place, the vast interests represented in the feeding of cattle and other live stock have received an equal share of attention, and although the questions involved are in the highest degree complicated and abstruse, an encouraging measure of success in approaching their solution has been attained.

In our agricultural meetings and publications we are discussing the same old questions as to the value and economy of the various kinds of cattle food, and the methods of raising them, that have been discussed ever since there have been two ways open to the farmer for keeping his animals.

So long as we do not understand what hay, corn-fodder, corn-meal, oil-cake, bran, shorts, brewers' grains, etc., are in their distinct parts, and how their separate ingredients individually stand related to the wants of the living, growing, laboring, milk-giving, or fattening animal, so long we shall remain in a fog of discussion, so long we shall oppose each other in argument, in belief and in practice; so long, like men bewildered in the forest, we shall travel in a circle, and tire ourselves out without making progress forward.

In the tables which I have alluded to, in which a vast amount of the work of the Experiment Stations has been condensed to its results, in compact numerical statement, we find given the average quantities of water, albuminoids, carbohydrates, fat and cellulose, that are contained in 1,000 parts of each of some 200 kinds of forage and feeding stuff. Chemical analysis encounters

extraordinary difficulties in its attempt to set forth the separate elements of food. Many of these difficulties are as yet but partially overcome, and many of our results are in some measure merely tentative and provisional; but a vast advance has been surely accomplished.

We can compare together hay and cornstalks, oats and corn-meal, peas and oil-cake, potatoes and turnips, by a comparison of their water, their albuminoids, their carbohydrates, their fat, and their fiber. We can also connect the preponderance of one or other class of ingredients with their observed use in cattle feeding.

The Experiment Stations have carried out a large number of feeding trials on oxen, cows, calves, horses, sheep, swine, and goats, taking account of the accurately weighed and analyzed food, not merely as so much hay, beets, etc., but also as so much water, fat, starch, gluten, etc.; and have thus given a new, more definite and more general expression to the results which practice had obtained.

As in the construction of a house, the builder must know not only the materials to be provided, but also the due proportions of them to be employed, so in the raising of a calf, in the fattening of an ox, in the support of a draught horse or of a milch cow, the farmer should know, not merely that water, oil, albuminoids, etc., are absolutely required, but also that they are demanded in such and such proportions. The nails and pins that are put into a house, beyond what are needed for binding the structure, are not only a waste of material in themselves, but may become a detriment to the building. So the want of due proportion among the elements of cattle food may be, and unquestionably is, in fact, an immense waste and damage to our agriculture.

In the Experiment Stations great numbers of practical trials have been carried out for the purpose of ascertaining the best quantities and proportions of the food-elements to use for the various purposes of the stock keeper, and the results that are now accepted as the best approximation to truth, are given in tables of so-called "Normal Rations."

These "Normal Rations" are confessedly approximate and imperfect; but they are based upon experiment, and they have an undeniable value. By their help the farmer can calculate the probably best combination of any sorts of cattle food that are at any time accessible to him. He can determine what to buy and what to sell to the best advantage of his cattle, his manure heap, and his cash on hand. And although the experimental foundation

of these tables is not yet broad enough to support all the deductions that may be made from them, they have been useful in practice, and are invaluable as a safe basis for further inquiries.

The builder, in making his estimates of the materials needful to construct a house, allows, in case of lumber, a large percentage for loss by defects and unavoidable waste in cutting. He also provides for a small waste of nails, while most of the other hardware required is expected to "hold out." The waste portions of cattle food must in like manner enter into the farmer's estimates. He must know to what degree the animal can build into its structure or otherwise make profitable use of the elements of all varieties of feeding stuff.

From this point of view, another class of investigations has been actively prosecuted for some ten years as to the digestibility of different foods; not with reference simply to what proportion of hay or potatoes or cotton-seed meal is dissolved and consumed in gross, but what proportions of the fat, of the starch, of the albuminoids, of the fiber, of the phosphates, etc., are utilized as nutriment. These investigations are made by feeding known quantities of analyzed food, keeping account of gain or loss of live weight, and also collecting, weighing and analyzing the urine and dung. What enters the animal as food, that cannot be found again unaltered in the excrement, has been digested.

The digestibility of a given cattle-food is not invariable, but changes according to the kind of animal, and the articles that accompany it in the ration; but by numerous experiments it is expected that a series of average figures will be obtained which will serve usefully as a basis for estimating the relative values of different feeding stuffs.

One of the interesting results of these researches is that the fiber or cellulose—the very wood—of plants is to a considerable degree digestible. It has "always" been known that the beaver subsists on wood and bark during winter, that cattle derive great satisfaction from browse, and that goats will eat newspapers and cotton cloth. Exact trials have shown that sheep are able to digest a large proportion of sawdust and of pure paper pulp, and that all farm animals readily convert into food from 40 to 70 per cent. of the fiber or woody matter of hay, straw and chaff. In fact, these materials have been proved to be not simply digestible "on a pinch," but really serviceable to a corresponding degree with starch, sugar, oil, etc. Accordingly, in most of the well con-

pounded cattle rations, the second rank in respect to quantity is occupied by cellulose or "crude fiber."

It is remarkable how differently the same elements of various kinds of forage submit to digestive action, as exhibited in the following results of this class of experiments.

Percentage of organic matter digested.

	No. of Experiments.	Total Organic Substance.	Albuminoids.	Fat.	Fiber.
Meadow hay,	45	64	59	50	62
Clover hay,	18	60	59	59	47
Clover, just before flower,	4	71	85	66	56
" in full flower,	2	64	69	61	50
" past flower,	2	58	59	44	39
Potatoes,	13	90	66	53	27
Linseed cake,	8	81	86	90	69
Cotton-seed cake (with hulls),	4	50	74	91	23
Oats,	9	69	75	78	20
Rye straw,	5	51	24	32	62

The above figures are simply averages of the results of trials made in most cases by different experimenters on different animals. In case of meadow and clover hay they are perhaps so numerous as to fairly establish the superiority of the former, by showing that although clover hay contains some four per cent. more albuminoids than grass hay, it gives no more of them to the support of animals, while its fiber is far less digestible. The influence of age on the digestibility of forage is strikingly seen in case of clover, the percentage value of which decreases rapidly during flowering and ripening. Potatoes and linseed cake are among the most concentrated and digestible of foods; and cottonseed cake, when free from hulls, ranks but little inferior to linseed cake. It is observed that rye straw is food to the extent of one-half its weight; while of the grain of oats 30 per cent. is undigested. But the albuminoids of oats are thrice more nutritious than those of rye straw; and the cellulose of the straw is thrice as nutritious as that of oats. The belief so prevalent in this country, that Indian corn is unsurpassed among the grains as a food, finds confirmation in these researches, its relative digestibility being higher than that of barley, as well as that of peas and beans. It is evident that experiments which promise to give us the data for comparing the digestibility of different foods, are of the utmost importance. By their aid the compounding of really normal rations will become a matter of satisfactory certainty, and the economy of cattle food will be *pushed to near its limits.*

A third direction in which the Experiment Station is proving of direct service to the farmer is in the examination of seeds as regards their genuineness, purity, and germinative quality. It is but a very few years since attention was directed in Great Britain to the wholesale distribution of purposely adulterated seeds throughout that country, and stringent laws and severe penalties were there enacted to protect the farmer.

There lately flourished in London, establishments where the business of "doctoring" turnip-seed was prosecuted on an extensive scale. Old and worthless seeds, or the seeds of inferior kinds of turnips, were killed and colored, and used to the estimated amount of 20,000 bushels annually for adulterating the seed of those varieties most sought for by farmers.

In London and on the continent hundreds of tons of the cheap yellow clover seed (*Medicago lupulina*) were and still are mixed in larger or smaller proportions with the red clover seed, and sold at the high price of the latter.

In 1868, three tons of so-called red clover seed were sold to farmers in the Saxon city of Chemnitz alone, of which two-thirds was yellow clover.

In Saxony light and inferior kinds of oats are extensively bought by seedsmen to adulterate the heavy and prized sorts.

The celebrated "Probstei rye" is annually produced to the extent of 2,800 to 3,400 bushels; but the amount ostensibly disposed of in the seed trade is hundreds of thousands of bushels.

Dr. Nobbe, Director of the Tharand Experiment Station, reports finding in a sample of tall meadow fescue grass (*Festuca elatior*) 70 per cent. of adulteration; and two samples of so-called "grass seed," having all the external appearance of a good article, were found to consist of grass flowers only, without a ripe seed of any sort.

The climax of this kind of ingenious villainy appears to have been reached in Hamburg, where there recently existed a manufactory of counterfeit clover seed, which was made from quartz sand, and with such skill as to deceive experienced judges, who have pronounced samples containing 25 per cent. of these quartz grains to be pure red clover seed.

In a sample of Timothy seed which had the appearance of being very pure, Dr. Nobbe found about 7 per cent. of foreign seeds, in which he identified 31 different kinds, mostly weeds and inferior grasses; and he calculated that upon a Saxon acre (= 1.37 Eng. acres) no less than 1,700,000 of these foreign seeds would be sown,

or 24 upon every square foot, by using the customary quantity of this pure Timothy seed.

Dr. Nobbe examined, during the first four years since the Tharand Experiment Station has given this matter attention, some 1,700 samples of seed. He determines not only the extent of adulteration with foreign seeds and mixtures, but he also ascertains, by careful sprouting trials, what percentage of the genuine seed is alive and capable of producing vigorous plants.

Dr. Nobbe has, by very numerous and laborious experiments upon seeds procured from various localities and climates, determined what must be regarded as the average per cent. of good seed that will sprout and grow, in a number of various kinds, when genuine. His experience shows that unadulterated white clover seed of which 66 per cent. will germinate is of average quality; flaxseed of which but one-half will sprout is poor; while dill seed of which 10 per cent. comes up is excellent.

Dr. Nobbe's experiments show further that very many genuine commercial seeds are of inferior quality, yielding much less than the proper average of plants, probably from admixture with the fresh stock, of old seed whose vitality is impaired or destroyed.

The many complaints that are made of the poor quality of the seeds sent out by the Agricultural Department at Washington are in large degree explained by these revelations of the state of the trade in Europe.

It is but six or seven years since Dr. Nobbe first called public attention to this subject. He has begun the publication of a book containing full descriptions and figures of all the useful and hurtful seeds that occur in commerce; and already at some twenty Experiment Stations farmers are able to get trustworthy examinations of seeds as to purity and vitality, and at a trifling cost.

To say that the farmers of Connecticut and of our entire country urgently need the aid and stimulus of the Experiment Stations, is to make a most evident assertion. Our Agricultural Colleges have but few agricultural students. The Agricultural Course of Instruction in this School is a supply that meets little demand. The reason lies mainly in the fact that our intellectual activity has the habit of running in other than agricultural channels. To bring our farmers in direct and profitable contact with the results of science, to bring science into active and visible coöperation with the toils and plans of the farm, would redound to the eminent advantage of both. The Experiment Station, I cannot doubt, is to be this point of contact, the focus of this coöperation.

SAMUEL W. JOHNSON.

Instruction in the Use of the Plane Table.

A class was again formed, during the summer of 1874, from the students of the School, to receive instruction in the use of the plane table and in field work under the operation of the United States Coast Survey; permission to that effect having been granted by Captain C. P. Patterson, Superintendent of the Coast Survey, to Mr. Richard Meade Bache, Assistant in charge of the region about New Haven. It was the original intention of Mr. Bache to place two parties from the School in the field, but the lateness of the passage of the Coast Survey appropriations by Congress prevented this, as before authority to act could be received most of the students had dispersed. The members of the school who volunteered were Messrs. E. C. Savage, George R. Cooley, A. A. Browning, and Henry A. Hazen, and the first of these was put in immediate charge of the party, and was rated and paid as an Aid *pro tem.* upon the Coast Survey. Mr. Bache has courteously furnished the Governing Board with a report of the operations of the party, in which he gives the statistics of the work, as follows:

Area,	1.8 sq. miles.
Length of streets and roads,	20.7 miles.
" " horse railroad,	1.9 "
" " steam railroad,	1.5 "

The map was inked at the end of the field season by Mr. E. C. Savage.

Contributions to the Study of the New Haven Region.

"I herewith enclose," Mr. Bache adds in his communication to the Board, "from last season's work, a list of such, and only such, statistics of my regular parties' operations as have heretofore been published in the Annual Report of the School. The operators in these parties were Messrs. Horace Andrews and Neville B. Craig, of whom Mr. Andrews executed the triangulation under my direction, and Mr. Craig the levelling, from which, among many other heights, the additional ones given are selected."

Permanent Bench Marks established between Tomlinson's Bridge and New Haven Light House.

Referred to the datum plane used by the City Surveyor's office, which is the mean high water at Chapel st. bridge, as determined by the Coast Survey tidal observations of 1870.

Quartz pebble in north wall of dike at the east end of Tomlinson's bridge—east end of wall—second stone from end, on top of wall and near the north-east corner of stone. 6.871 ft.

East corner of granite post, at the north-east corner of Ft. Hale property, and situated on the north side of north road leading to Ft. Hale. 2.862 ft.

Copper bolt in wall on the north side of the sluiceway at Ft. Hale. 5.385 ft.

South corner of granite post, at the south-east corner of the Ft. Hale property, and near the south-west corner of the west saltpetre works. 4.015 ft.

North-west corner of granite post, situated about 109.5 feet from the last bench, and on the opposite side of road. 2.757 ft.

On top of stone post on west side of east entrance to yard of first house west of George Nettleton's hotel at Morris Cove. 16.556 ft.

Copper bolt placed in solid rock a few feet west of New Haven light-house, and marked ⊕ 11.187 ft.

*Geographical Positions in the Vicinity of New Haven, Conn.**

Name of Station.	Latitude.			Longitude.		
	°	′	″	°	′	″
Ives's Cupola,	41	18	29.288	72	52	31.704
Sandy Point (signal on beach),	41	16	01.741	72	55	14.830
Wire Works' Chimney,	41	17	53.682	72	53	23.355
Townsend's Cupola,	41	16	31.786	72	53	24.976
Peak on House (east shore),	41	16	33.499	72	53	53.809
White House Cupola (east shore),	41	17	22.055	72	53	49.793
Mitchell's Cupola (S. W. corner)	41	16	23.856	72	53	26.925
Chemical Works (wooden ventilator),	41	16	05.478	72	53	47.054
Rod (supporting telegraph wire),	41	18	54.423	72	52	54.424
Slaughter House (east cupola),	41	19	14.876	72	53	12.980
School House Cupola (adjusted),	41	18	32.793	72	53	06.043
Baldwin's Cupola (adjusted),	41	17	40.244	72	53	21.781
2d Cong. Church (Fair Haven, east side),	41	18	25.498	72	52	48.509
North (signal pole),	41	17	33.479	72	53	55.567
Crane's Bar (signal pole),	41	17	03.730	72	53	53.663
East (signal pole),	41	16	56.350	72	53	38.218
Red and White (signal pole),	41	17	04.637	72	53	28.775
Fort Hale (signal pole),	41	16	12.372	72	53	58.301
North Watch House (signal pole),	41	16	41.993	72	54	49.210
Grove (signal pole),	41	19	00.580	72	52	36.932
Pine Street (signal pole),	41	18	45.386	72	52	56.263
Shell Heap (signal pole),	41	18	41.189	72	52	38.638
Peck Street (signal pole),	41	19	00.047	72	52	58.715
North Quinnipiac (signal pole),	41	19	26.326	72	53	00.479
South West Ledge Light House,	41	14	01.724	72	54	24.800

Distances between Triangulation Points within the New Haven Region.

		Feet.
Ives's Cupola to	West Rock,	23,731.45
" "	Tall Spire,	3,535.58
" "	South Church,	14,336.70
" "	Baldwin's Cupola,	6,264.14
" "	2d Cong. Church, Fair Haven,	1,338.55
" "	School House Cupola,	2,644.07
" "	Grove Signal,	3,191.53
" "	Peck Street Signal,	3,733.08
" "	Pine Street Signal,	2,482.90

* To reduce these positions, as well as those previously published, to the most recent astronomical data of the Coast Survey, add 0.″30 to the latitude and 20.″43 to the longitude. It is not done here, to avoid want of uniformity with previous publication in the Report, and was not done there, because the Coast Survey had not then made the general change.

South Church	to Baldwin's Cupola,	10,045.18
"	" Sandy Point Signal,	11,147.89
"	" Mitchell's Cupola,	13,036.95
"	" Townsend's Cupola,	12,621.90
"	" Chemical Works' Ventilator,	13,384.22
"	" Fort Hale,	12,313.04
"	" Crane's Bar,	8,944.34
"	" Peak on House,	10,886.64
"	" White House Cupola,	8,379.26
"	" Wire Works' Chimney,	9,868.17
"	" North Watch House.	7,736.74
"	" North Signal,	7,617.83
"	" East Signal,	10,340.01
Sandy Point Signal	to Townsend's Cupola,	8,921.29
"	to Mitchell's Cupola,	8,537.10
"	" North Watch House,	4,518.67
"	" Chemical Works,	6,712.67
"	" White House Cupola,	10,402.02
"	" Fort Hale Signal,	5,941.31
"	" Crane's Bar Signal,	8,817.59
"	" Peak on House,	6,970.89
"	" Forbes' Signal,	12,411.34
"	" North Signal,	11,081.53
"	" East Signal,	9,216.42
Townsend's Cupola	to Mitchell's Cupola,	816.17
"	to Fort Hale Signal,	3,214.63
"	" Crane's Bar Signal,	3,904.45
"	" Peak on House,	2,208.01
Chemical Works' Ventilator	to Peak on House,	2,882.16
Baldwin's Cupola	to Tall Spire,	5,285.26
"	to East Rock,	12,585.26
Crane's Bar Signal	to Peak on House,	3,059.33
"	to White House Cupola,	1,877.89
"	" North Signal,	3,014.10
"	" East Signal,	1,395.67
"	" Red and White Signal,	1,902.02
Fort Hale Signal	to Crane's Bar Signal,	5,209.36
"	to Peak on House,	2,165.34
"	" North Watch House Signal,	4,908.31
Wire Works' Chimney	to East Rock,	11,245.83
North Watch House Signal	to Forbes's Signal,	7,945.40
Slaughter House Cupola	to North Quinnipiac Signal,	1,500.71
East Signal	to Red and White Signal,	1,105.92
"	to Peak on House,	2,600.75
"	" North Signal,	3,984.02
Grove Signal	to Tall Spire,	4,229.69
"	" Slaughter House Cupola,	3,107.54
"	" Telegraph Rod,	1,472.84
"	" Pine Street Signal,	2,130.58
"	" Shell Heap Signal,	1,966.69
"	" Peck Street Signal,	1,662.81
"	" North Quinnipiac Signal,	3,164.77
Peck Street Signal	to Fair Haven 2d Cong. Church,	3,582.03
"	to Slaughter House Cupola,	1,853.76
"	" Telegraph Rod,	656.64
"	" Shell Heap Signal,	2,447.23
"	" North Quinnipiac Signal,	2,662.80
Shell Heap Signal	to Fair Haven 2d Cong. Church,	1,757.41
"	to School House Cupola,	2,257.08
"	" Telegraph Rod,	1,801.23
"	" Pine Street Signal,	1,410.39
S. W. Ledge Light House	to West Rock,	38,125.96
"	" " South Milford,	30,074.86

Additions to the Zoological Collections.

A. E. Verrill, Curator; S. F. Clark, Assistant.

The most numerous additions to the Zoological department are the extensive collections of marine invertebrates made in connection with the explorations under Prof. S. F. Baird, U. S. Commissioner of Fish and Fisheries. During the past summer the headquarters of the Commission were established at Noank, Conn., and the investigation of the marine invertebrate fauna was put under the general charge of the curator, but a large number of other naturalists aided, more or less, in this work; among them Mr. S. I. Smith, Mr. Oscar Harger, and Mr. S. F. Clark, of this School; Prof. A. Hyatt and Mr. Robert Rathburn, of Boston; Dr. Joseph Leidy, of Philadelphia; Dr. E. Bessels, of Washington. Mr. R. Y. Brown, of the University of Wisconsin; Mr. G. R. Kleeberger, Mr. J. C. Olmstead, and Mr. F. M. Turnbull, students in this School, also took part in the work, and availed themselves of the facilities offered for the study of marine zoology and botany. Extensive dredgings were made by means of the U. S. Steamer "Bluelight," Commander L. C. Beardslee, in the waters of Long Island Sound; Fisher's Island Sound; Gardiner's Bay; Peconic Bays; Block Island Sound; and the deeper waters off Block Island and the eastern end of Long Island. This collection of invertebrata has been deposited in the North Sheffield Hall, to be examined and reported upon by the curator and Mr. S. I. Smith, when a complete series of the specimens will be given to the college museum. Much work has been done during the past year upon this and the previous collections of the same kind, made during 1872 and 1873. Mr. Smith, Mr. Clark, and Mr. Harger have aided the curator in this work.

In September, the Superintendent of the U. S. Coast Survey offered to Prof. Baird the use of the Coast Survey steamer Bache, Capt. Platt, for the purpose of continuing the dredgings in deep water off the coasts of Maine and New Hampshire. Dr. A. S. Packard, of Salem, Mass., was put in charge of this expedition, and he was assisted by Mr. C. Cooke, of Salem, and Mr. Robert Rathburn, of Boston. They obtained a valuable collection of the deep-water animals of the Gulf of Maine, which has also been sent to this School for examination and description. A preliminary report upon the results of the last named expedition has been published in the American Journal of Science by the curator. We have also received from the U. S. Fish Commission several

large fishes taken near Noank, the skins of which have been mounted and put on exhibition. Among these are the drum-fish, the tarpum (*Megalops thrissoides*), and bill-fish (*Tetrapturus albidus*). These are rare species on the coast of New England.

A good collection of shells, corals, echinoderms, and crustacea, from Florida and the Bahamas, was purchased of Dr. E. Palmer. A very valuable and useful collection of typical crustacea was obtained by exchange from the University of Christiania, through Dr. G. O. Sars. A small but valuable collection of typical Hydroids and Ophiurans was received from the Museum of Comparative Zoology, in exchange.

Mr. J. F. Whiteaves has sent a collection of invertebrates from the deep waters of the Gulf of St. Lawrence. Mr. J. H. Emerton has labelled most of our spiders, and has sent a considerable number of additional ones.

Professor Marsh has continued to make numerous and valuable additions to the osteological collection, as in previous years.

Professor Dana has given many valuable books to the zoological department of the museum.

Several works relating to the culture and fisheries of oysters were presented by Capt. G. H. Townsend.

Other donations, of less importance, have been received from a number of persons, and will be acknowledged on another occasion.

Additions to the Geological Collections.

O. C. Marsh, Curator; O. Harger, Assistant.

The additions to the Geological department of the Museum have been very large during the past year. In the West, twelve parties of collectors were employed by the curator during the summer and autumn months, and many thousand specimens of Cretaceous and Tertiary vertebrate fossils were thus obtained, among them many new to science. In October last, the curator organized an expedition to the Miocene "Bad Lands" south of the Black Hills, more especially to examine a remarkable fossil locality discovered a few months previously. The explorations were very successful, notwithstanding extremely cold weather (15° to 20° below zero), and the continued hostility of the Sioux Indians. The latter refused to allow the expedition to cross White River, but a reluctant consent was at last obtained. They afterwards stopped the party on the way to the "Bad Lands," attempted a night attack on their camp, and otherwise molested

them. The fossil deposits explored were mainly of Miocene age, and although quite limited in extent, proved to be rich beyond expectation. Nearly two tons of fossil bones were collected, most of them rare specimens, and many unknown to science. Among the more interesting remains found were several species of gigantic *Brontotheridæ*, nearly as large as Elephants. Successful explorations were made also in the Pliocene of the same region.

Among the important vertebrate fossils secured during the last year, and already described by the curator, are several forms of Quadrumana from the Eocene and Miocene; a number of species of a new order (*Tillodontia*) of Eocene Mammals; a new genus of *Brontotheridæ;* numerous Tertiary Mammals allied to the Horse; and the first horned Rhinoceroses discovered in this country.

One of the most interesting specimens added to the museum is a nearly complete skeleton of *Mastodon Americanus*, found by Mr. Andrew Mitchell, on his farm in Otisville, Orange County, New York. This skeleton belonged to a fully adult animal, and is in better preservation than any yet discovered in this country.

The Osteological collection of this department has been greatly increased during the year. Several hundred skeletons, especially of Mammals and Birds, have been added, representing many rare types. The most important acquisition in Osteology was a large collection of skeletons and skulls, purchased of Dr. H. W. Boyd of Chicago. Among these was a fine series of Quadrumana, including Gorillas, Chimpanzees, and Orangs, and a Whale, over seventy feet in length, from the Pacific Coast.

Mr. G. B. Grinnell (class of 1870), Palæontologist of the Black Hills Expedition under Gen. Custer, and Mr. F. H. Hoadley (class of 1870) of New Haven, have rendered important service to the Geological department of the Museum, during the past year, especially in arranging and classifying the collections.

The new Peabody Museum Building is now in process of construction, and it is expected that during the next year all the collections of this Department will be placed in it, and be accessible.

Donations to the Metallurgical Museum.

The most noteworthy additions to the Metallurgical Museum are a suite of Zinc ores from the Passaic Mine, Stirling Hill, New Jersey, presented by Henry S. Manning, Esq. (S. S. S. 1863), of Manning & Squier, New York City; and specimens of Silver ore from the great Comstock Bonanza, California, Mine, Virginia City, Nevada, the gift of Hon. William Alvord, San Francisco, Cal.

Public Lectures.

The ninth annual course of lectures to mechanics and others was given during the past year in the lecture room in North Sheffield Hall. The lecturers and their subjects are indicated in the annexed programme.

I.	Mon., Feb.	1. Modern Glaciers (1),	W. H. Brewer.
II.	Thurs., "	4. The Growth of Language (1),	W. D. Whitney.
III.	Mon., "	8. Modern Glaciers, (2),	W. H. Brewer.
IV.	Thurs., "	11. The Growth of Language (2)	W. D. Whitney.
V.	Mon., "	15. Agricultural Experiment Stations,	S. W. Johnson.
VI.	Thurs., "	18. The Growth of Language (3),	W. D. Whitney.
VII.	Mon., "	22. The Gulf Stream,	W. P. Trowbridge.
VIII.	Thurs., "	25. The Growth of Language (4),	W. D. Whitney.
IX.	Mon., March	1. Ancient Glaciers,	A. E. Verrill.
X.	Thurs., "	4. Chemical Analysis,	W. G. Mixter.
XI.	Mon., "	8. On the New Revision of the English Bible,	President Woolsey.
XII.	Thurs., "	11. The National Debt,	F. A. Walker.
XIII.	Mon., "	15. Cotton,	D. C. Eaton.
XIV.	Thurs., "	18. Magnetism,	C. S. Lyman.

Gifts to the Institution.

A powerful electro-magnet, with auxiliary apparatus, has been very generously presented to the School by its manufacturer, William Wallace, Esq., of Ansonia.

The soft iron cores of the magnet, each two feet long and four inches in diameter, are bolted to a heavy iron block, and are surrounded each by four spools of insulated copper wire No. 8, each spool containing 32 pounds of wire in 11 layers of 33 convolutions to a layer, the total length of wire being nearly a mile. The magnet is very conveniently mounted on trunnions in a heavy mahogany frame, so as to be readily used in any position. To the free ends of the cores are fitted elaborately constructed and massive iron pieces, which carry the polar terminals, and these terminals (of which there are three pairs) are adjustable for distance apart by large hand-screws. There is also a massive armature to connect the two cores for lifting, when the polar pieces just described are removed. Besides the solid cores already mentioned there is an extra pair of hollow ones, each having a central cavity two inches in diameter, and at one side a quarter of an inch slot cut entirely through the tube from end to end. These cores may be jointed to each other endwise by a double connecting screw, so as to form a straight magnet four feet in length.

The principal auxiliary pieces are for exhibiting the effects of induced currents. They comprise a one and three-sixteenths inch copper cube for rotation; a heavy copper plate 28 inches long, 5 wide, and about two-tenths thick, connected by brass rods with an axis of suspension 5 feet above, so as to vibrate lengthwise, as a pendulum, between the poles; and a copper disk of the same thickness and 18 inches in diameter, which is made to rotate rapidly between the poles by means of a crank and heavy frictional gearing.

The lifting force of the magnet is estimated at eleven tons.

To this munificent gift Mr. Wallace has since added a very valuable piece of apparatus, consisting of a coil 12 inches long and 5½ inches diameter, with a movable iron bar an inch in diameter and 18 inches long, for vibrating vertically in the central cavity; the whole mounted on a mahogany stand.

From the Class of 1872, through its Secretary, Mr. C. L. Johnson, the Governing Board acknowledge the receipt of a gift of $400.

The Library has been also the recipient of gifts from various persons, among which may be mentioned thirteen volumes of fac similes of the medals and other works of art preserved in Rome, presented by Mr. Sheffield; five volumes, with atlas, of Karsten's Metallurgie, presented by Mr. H. Holland of Westfield, Mass.; and the various publications of the Engineer Department of the United States Army.

Necessity for Increased Endowments.

The Governing Board are again under the unpleasant necessity of making reference to the need of additional endowment for the proper maintenance of the School; and they feel it to be due both to themselves and to the friends of the institution that the precise facts should be made known. For the past two years, in spite of the most rigorous economy, the annual expense has exceeded the annual income. True, the deficit has thus far been comparatively small; but the cause which produced it is still in active operation, and is likely to become more powerful with each succeeding year. The additional teaching force required for the steadily increasing number of students cannot be paid for from the income received from tuition alone; and above a certain point every additional student is a drain upon the resources of the institution. It is obviously the wish of all interested in the prosperity of the

School that the number of thoroughly prepared pupils connected with it should constantly become greater; but it is certainly full as desirable that the efficiency of the instruction given should not be impaired. The only practicable way to economize at present, so as to make the resources of the School meet its current expenses, is either to cut off a portion of the present teaching force, or to employ inferior instructors at smaller salaries; neither of which alternatives the Governing Board are disposed to look upon with the slightest favor. They are necessarily compelled to call upon the friends of scientific education, and to once more ask that additional efforts may be made to secure a still larger endowment to the permanent fund of the School.

ANNIVERSARY.

The anniversary exercises were held in North Sheffield Hall on the evening of Tuesday, June 23, 1874. Nine theses were selected for public reading.

The candidates for degrees, with the subjects of their theses, are given in the following schedule. Those marked with an asterisk were read in the evening.

CANDIDATES FOR DEGREES,

WITH THE SUBJECTS OF THEIR GRADUATING THESES.

CIVIL ENGINEERS. (2)

JOSEPH JACKSON ABBOTT, Ph. B., *New Haven.* Design of an Iron Bridge of Large Span (Murphy-Whipple Truss).

JOSEPH JOHN SKINNER, Ph. B., *New Haven.* Design of an Iron Bridge of Large Span (Post Truss).

BACHELORS OF PHILOSOPHY. (36)

HENRY PRENTISS ARMSBY (Chemistry), *Millbury, Mass.* On the Nitrogen of the Soil.

NATHAN EDWARD BECKWITH (Civil Engineering), *New Haven.* On Natural Hydraulic Cement.

CHARLES COOK BREWSTER (Civil Engineering), *Norwich.* On Foundations under Water.

EDWARD BRUSH (Civil Engineering), *Greenwich.* A Review of the Foundation of the Pier of the East River Bridge.

ARTHUR BUCKLIN CLAFLIN (Select), *Boston, Mass.* On Cabinet Government.

FRANKLIN EDWARDS (Civil Engineering), *Northampton, Mass.* On the Water Works of Northampton, Mass.

CHARLES HOWARD FITCH (Dynamic Engineering), *New Haven.* On Rotary Steam Engines.

EDWIN HORACE FORBES (Civil Engineering) *Cromwell.* A Review of the Canal at Windsor Locks.

LE ROY GALE (Medical), *New York City.* On the Reproduction and Metamorphoses of the *Bufo Americanus.*

JACOB HOUTZ GROVE (Select), *Fredericksburg, Pa.* On the Origin and Growth of the Jury System.

VINCENT GILPIN HAZARD (Dynamic Engineering), *West Chester, Pa.* On Belting.

FRANK LEROY HOLT (Select), *Rockville.* On the Relations of the Physical Geography of the United States to their Settlement.

ALLEN BREWER HOWE (Metallurgy), *Troy, N. Y.* On the Nature and Manufacture of Spiegel-Iron.

*HENRY HUN (Medical), *Albany, N. Y.* On the Luminous and Non-Luminous Flames of the Bunsen Burner.

*LORENZO M. JOHNSON (Civil Engineering), *Rochester, Mass.* On the Hoosac Tunnel.

HENRY JARVIS KELLOGG (Civil Engineering), *Milford.* A Review of the Swing Bridge over the Housatonic River on the N. Y., N. H. & H. R. R.

CHARLES HITTELL KILLINGER (Chemistry), *Lebanon, Pa.* On the Cornwall Iron Ore Bank in Lebanon County, Pa.

BEVERLY LIVINGSTON (Medical), *New York City.* On the Marine Algae of Long Island Sound.

WILLIAM PITT LYNDE (Dynamic Engineering), *Milwaukee, Wisc.* On Governors.

*WILLIAM MCGRATH (Civil Engineering), *Bridgeport.* A Review of a Roof Truss in the Grand Central Depot, New York City.

*CHARLES JAMES MORSE (Civil Engineering), *Poland, O.* A Review of the Iron Blast Furnace at Struthers, Ohio.

GEORGE SMITH NEEDHAM (Civil Engineering), *Louisville, Ky.* On the Ohio Falls Bridge at Louisville, Ky.

*EUGENE ERNEST OSBORN (Civil Engineering), *Norwalk.* On Pavements.

RICHARD DEANE ARDEN PARROTT (Chemistry), *Greenwood Works, N. Y.* On the Working of the Clove Furnace at Greenwood, N. Y.

CLAUDIUS VICTOR PENDLETON (Dynamic Engineering), *Bozrah.* On Compound Engines.

*WALTER BREWSTER PLATT (Medical), *Waterbury.* On the Anatomy of the Quahog-clam (*Venus Mercenaria*).

*GEORGE COFFIN POWER (Civil Engineering), *Hudson, N. Y.* A Review of the Draw of Harlem Bridge.

WILLIAM SPENCER PRATT (Civil Engineering), *New Haven.* On Cement *vs.* Glazed Pipe for Sewage Purposes.

WILLIAM HENRY REYNOLDS (Civil Engineering), *New Haven.* A Review of an Iron Road-Bridge over the Quinnipiack River at Wallingford, Conn.

*WILLIAM ROCKWELL (Dynamic Engineering), *Bridgehampton, N. Y.* On Explosives and their Applications.

WILLIAM ARTHUR ROGERS (Metallurgy), *Covington, Ky.* On the Bessemer Steel Process.

JOHN MUIRHEAD STEWART (Civil Engineering), *Peekskill, N. J.* On the Lyman Viaduct.

FRANCIS HILL STILLMAN (Dynamic Engineering), *Plainfield, N. Y.* On the Teledynamic Transmission of Power.

*WILLIAM RICHARDSON UPHAM (Medical), *Yonkers, N. Y.* On Lygodium Palmatum.

SIMEON HARRISON WAGNER (Civil Engineering), *West Haven.* On Double Reversible Continuous Rail for Railway Tracks.

JOHN CHARLES WEBER (Civil Engineering), *New York City.* A Review of the Stone Bridge over Mill River on the H. & N. H. R. R.

PRIZES.

CLASS OF 1874.

For excellence in German, the prize awarded to HENRY HUN, *Albany, N. Y.*, with honorable mention of EUGENE E. OSBORN, *Norwalk.*

For excellence in French, the prize awarded to HENRY HUN, *Albany, N. Y.*

For excellence in Civil Engineering, the prize awarded to CHARLES J. MORSE, *Poland, O.*

CLASS OF 1875.

For excellence in Mathematics of Junior Year, the prize divided between CHARLES HILDEBRAND, *New Haven*, and WILLIAM F. PRATT, *New Haven.*

For excellence in Chemistry, the prize awarded to FREDERIC N. PEASE, *Ellington.*

For excellence in Mineralogy, the prize awarded to FREDERIC N. PEASE, *Ellington.*

CLASS OF 1876.

For excellence in all the studies of Freshman Year, the prize awarded to HIRAM A. MILLER, *New Haven.*

For excellence in German, the prize awarded to MAX MAILHOUSE, *New Haven*, with honorable mention of FREDERIC P. DEWEY, *West Haven*, and STANLEY FORBES, *San Francisco, Cal.*

For excellence in Mathematics, the prize awarded to HIRAM A. MILLER, *New Haven.*

For excellence in Physics, the prize awarded to HIRAM A. MILLER, *New Haven.*

For excellence in Mechanical Drawing, the prize awarded to GEORGE C. DUNHAM, *Southington.*

ERRATUM.

On page xxxi, line 19, for "September 10," read "September 16."

PROGRAMME OF STUDIES,

AND

CATALOGUE,

For the College Year 1874--75.

CALENDAR.

1874.		
10 Sept.	Thursday,	First Term begins.
17 Dec.	Thursday,	First Term ends.
1875.		**Winter Vacation of three weeks.**
7 Jan.	Thursday,	Second Term begins.
8 April,	Thursday,	Second Term ends.
		Spring Vacation of two weeks.
22 April,	Thursday,	Third Term begins.
29 June,	Tuesday,	Meeting of Appointing Board.
29 June,	Tuesday,	Anniversary.
1 July,	Thursday,	Commencement.
2, 3 July,	Friday, Sat.,	Examination for Admission.
		Summer Vacation of eleven weeks.
14, 15 Sept.	Tues.. Wedn.,	Examination for Admission.
16 Sept.	Thursday,	First Term begins.
23 Dec.	Thursday,	First Term ends.

ABBREVIATIONS.

S. H.	Sheffield Hall.
N. S. H.	North Sheffield Hall.
TR.	Treasury Building.
D.	Durfee College.
F.	Farnam College.
S. M.	South Middle College.
D. H.	Divinity Hall.
W. D. H.	West Divinity Hall.

In the buildings belonging to the Sheffield Scientific School, the rooms numbered from 1 to 21 are in Sheffield Hall: from 26 to 58 in North Sheffield Hall.

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BY AUTHORITY OF THE SUPERINTENDENT OF THE SURVEY.

RICHARD M. BACHE, of the U. S. Coast Survey,
The Use of the Plane Table. 12 Home pl.

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John Gilbert Bramley,	*Bovina, N. Y.*	248 Elm st.
George Loomis Brownell,	*East Haddam,*	32 Bristol st.
Amos Avery Browning,	*Norwich,*	60 W. D. H.
Charles Stuart Bunce,	*Glastenbury,*	56 W. D. H.
Frank Taylor Chambers,	*Wilmington, Del.*	122 College st.
Edward Benjamin Chandler,	*Woodstock,*	85 Bradley st.
John Henry Chapman,	*New York City,*	46 Elm st.
William Alexander Christie,	*Newport, R. I.*	42 York sq. pl.
Arthur Eugene Clarke,	*Batavia, N. Y.*	420 Chapel st.
George Rufus Cooley,	*Hamden,*	420 Chapel st.
Chambers McKibbin Craig,	*Alleghany City, Pa.*	42 Prospect st.
James Cunningham,	*Pittston, Pa.*	149 College st.
Charles William Fenn,	*Portland, Me.*	86 W. D. H.
Charles Hamilton Fox,	*Lansingburgh, N. Y.*	489 Chapel st.
James Freeland,	*New York City,*	92 Grove st.
Luther Henry Gager,	*Coventry,*	105 Howe st.
Livingston Gifford,	*Jersey City, N. J.*	191 Temple st.
John Starr Griffing,	*New Haven,*	114 Chapel st.
William Cornelius Hall,	*Buffalo, N. Y.*	161 Temple st.
Henry Mortimer Hastings,	*Oswego, N. Y.*	55 Trumbull st.
Alfred Pell Haven,	*New York City,*	73 Trumbull st.
Charles Hildebrand,	*New Haven,*	16 Chestnut st.
Thomas Douglas Hoxsey,	*Paterson, N. J.*	116 College st.
William Read Howe,	*Orange, N. J.*	64 Whitney av.
Julian Kennedy,	*Struthers, O.*	30 Bristol st.
Edward Austin Kent,	*Buffalo, N. Y.*	64 Whitney av.
George Reinard Kleeberger,	*Apple River, Ill.*	30 Bristol st.
Wells Cushman Lake,	*Lake Forest, Ill.*	8 Trumbull st.
Charles Purdy Lindsley,	*New Haven,*	132 Olive st.
Blanchard Lynde,	*Milwaukee, Wisc.*	191 Temple st.
Clarence Fake McMurray,	*Lansingburgh, N. Y.*	116 College st.
Burton Mansfield,	*New Haven,*	50 Lyon st.
John Charles Olmsted,	*New York City,*	189 Church st.
Edward Day Page,	*South Orange, N. J.*	76 Howe st.
Frederic Noah Pease,	*Ellington,*	32 Bristol st.
William Edward Peirce,	*Raleigh, N. C.*	32 Bristol st.
Dwight Edward Pierce,	*New Haven,*	109 Elm st.

William Arthur Pratt,	*New Haven,*	8 Gill st.
William Shugard Righter,	*Newark, N. J.*	8 Lock st.
Walter Coe Roberts,	*New Haven,*	8 Brown st.
Richard Sharpe,	*Eckley, Pa.*	48 College st.
Clarence Hoyt Stilson,	*Cleveland, O.*	205 Orange st.
Jared Sidney Torrance,	*Gowanda, N. Y.*	27 Temple st.
Frederick Moncrieff Turnbull,	*Hartford,*	27 Prospect st.
George Leland Upham,	*Yonkers, N. Y.*	159 Temple st.
Alonzo Earl Wemple,	*Brooklyn, L. I.*	8 Lock st.
William Rodman Wharton,	*Germantown, Pa.*	8 Lock st.
Alfred Newton Wheeler,	*Southford,*	59 Wooster st.
Henry Stacy Whipple,	*Birmingham,*	64 High st.
Edward Luther White,	*Waterbury,*	159 Temple st.
George Horace Wilcox,	*West Meriden,*	116 College st.
Frederick Wood,	*Norwalk,*	55 Trumbull st.
Kenjiro Yamagawa,	*Japan,*	29 High st.

SENIORS, 56.

JUNIOR CLASS.

David Root Alden,	*Westville,*	Westville.
Halsey Warren Allen,	*Jersey City, N. J.*	119 W. D. H.
Evelyn Marcelon Andrews,	*Norwich,*	22 Trumbull st.
Charles Eben Bacon,	*Middletown,*	55 W. D. H.
Charles Loring Brace,	*Hastings, N. Y.*	189 Church st.
James Henry Brewster,	*New Haven,*	77 Wall st.
Frank Elwood Brown,	*West Haven,*	West Haven.
William McCulloh Brown,	*Brookline, Mass.*	143 York st.
Will C. Browning,	*Norwich,*	60 W. D. H.
Hermon Beardsley Butler,	*New York City,*	66 W. D. H.
Walter Cleveland Butler,	*New Haven,*	113 Olive st.
Lloyd Joseph Caswell,	*Norwich,*	227 Crown st.
Sidney William Clark,	*Hartford,*	223 Elm st.
Frank Welles Crowell,	*Brooklyn, N. Y.*	156 York st.
John Moffat Cunningham,	*Poughkeepsie, N. Y.*	149 College st.
Frederick Perkins Dewey,	*West Haven,*	8 Lock st.
Charles Dickinson,	*Fordham, N. Y.*	159 Temple st.
George Cornwell Dunham,	*Southington,*	66 Bradley st.
John Sherman Fitch,	*New Haven,*	46 High st.
Frederic Hodgeman Foote,	*Port Henry, N. Y.*	99 Wall st.
Stanley Forbes,	*San Francisco, Cal.*	144 Orange st.
Edward Livingston Ford,	*Niagara Falls, N. Y.*	48 College st.
Porter Dwight Ford,	*Washington,*	227 Crown st.
Edward Jasper Francke,	*New York City,*	9 Library st.
Robert Jackson Gibson,	*New Haven,*	44 Edwards st.

William Wesley Gibson,	*New Haven*,	44 Edwards st.
Edward Gillette,	*New Haven*,	15 Columbus st.
Jack Hays Hammond,	*San Francisco, Cal.*	65 W. D. H.
James Lawrence Houghteling,	*Chicago, Ill.*	167 Temple st.
Randell Hunt,	*New Orleans, La.*	65 W. D. H.
Edward Hine Johnson,	*Brooklyn, N. Y.*	94 Grove st.
James Tewksbury Law,	*Tarrytown, N. Y.*	94 Grove st.
Thomas Howard Linsley,	*West Meriden*,	66 W. D. H.
John Francis Luby,	*New Haven*,	21 Nash st.
Albert Sutton Macgregor,	*New York City*,	161 Temple st.
Max Mailhouse,	*New Haven*,	49 Meadow st.
Howard Meyer,	*New York City*,	161 Temple st.
Frederick Plumb Miles,	*Salisbury*,	64 W. D. H.
Hiram Allen Miller,	*New Haven*,	58 W. D. H.
William Mayo Newhall,	*San Francisco, Cal.*	165 Temple st.
Miles Greenwood Nixon,	*Chicago, Ill.*	161 Temple st.
John Robert Paddock,	*Cheshire*,	34 York sq. pl.
William Beach Palmer,	*Bridgeport*,	69 W. D. H.
Nathaniel Chapin Ray,	*West Haven*,	271 Chapel st.
Edward Larned Ryerson,	*Chicago, Ill.*	167 Temple st.
William Babcock Sawyer,	*Buffalo, N. Y.*	55 Trumbull st.
Charles David Seeberger,	*Chicago, Ill.*	59 W. D. H.
Andrew Gilbert Sheak,	*Binghamton, N. Y.*	55 W. D. H.
Gordon Edward Sherman,	*Morristown, N. J.*	165 Temple st.
George Watson Smith,	*Chicago, Ill.*	167 Temple st.
LeGrand Smith,	*Chicago, Ill.*	167 Temple st.
George Franklin Taylor,	*Willimantic*,	63 W. D. H.
Francis Augustus Terry,	*Lyme*,	58 W. D. H.
Allan Mason Thomas,	*Wickford, R. I.*	458 Chapel st.
Frederick William Vanderbilt,	*New York City*,	161 Temple st.
Charles Williams Van Vleck,	*Cincinnati, O.*	489 Chapel st.
Thomas Alfred Vernon,	*Brooklyn, N. Y.*	86 W. D. H.
Alfred Elisha Walker,	*Orange*,	85 Church st.
Charles Alexander Watson,	*Hartford*,	156 York st.
David Agnew Weyer,	*Madison, Ind.*	169 Temple st.
David Willard Williams,	*Glastenbury*,	56 W. D. H.
Thomas Yeatman,	*New Haven*,	119 W. D. H.

JUNIORS, 62.

FRESHMAN CLASS.

William Whittlesey Abbott,	*Yarmouth, Me.*	29 Prospect st.
Shiro Akabane,	*Yedo, Japan,*	11 Grove st.
Alvin Driggs Ayres,	*Woodmont,*	8 Lock st.
Thomas Sanford Beaty,	*Indianapolis, Ind.*	Chapel st.
William Henry Backus,	*Cleveland, O.*	15 Home pl.
George Henry Bartlett,	*North Guilford,*	157 Church st.
Charles Coffing Beach,	*Hartford,*	159 Temple st.
Morris Burke Belknap,	*Louisville, Ky.*	14 Lock st.
Bernard Berens,	*Philadelphia, Pa.*	Chapel st.
Arthur Lewis Betts,	*Norwalk,*	Westville.
Frank Lewis Bidwell,	*Kansas City, Mo.*	533 Chapel st.
Thomas Marcus Blakslee, PH.B. Madison University.	*Hamilton, N. Y.*	324 Elm st.
John Edwards Buddington,	*Huntington,*	Huntington.
David Erwin Burton,	*Erie, Pa.*	134 College st.
Frank Caldwell,	*Carthage, O.*	464 Chapel st.
Joseph Gilbert Calhoun,	*Hartford,*	533 Chapel st.
Thomas Lincoln Casey,	*Washington, D. C.*	464 Chapel st.
Alfred Chapman,	*Bethel,*	104 Grove st.
Clarence Augustus Claflin,	*Hopkinton, Mass.*	458 Chapel st.
Frederick Leonard Cowles,	*New Haven,*	632 Chapel st.
Henry Holbrook Curtis,	*New York City,*	42 Grove st.
Judson Amos Doolittle,	*Cheshire,*	34 York sq. pl.
William Sidney Downs,	*Birmingham,*	119 W. D. H.
Edward Caldwell Earle,	*New Haven,*	214 Orchard st.
Wallace Bruce Fenn,	*New Haven,*	191 Church st.
Burr Kellogg Field,	*Germantown, Pa.*	157 George st.
Joachim John Francke,	*New York City,*	9 Library st.
Allan Murray Gale,	*New Haven,*	87 Trumbull st.
William Edgar Gard,	*Chicago, Ill.*	49 Meadow st.
Charles Cortledge Godfrey,	*Southport,*	41 College st.
William Augustus Goodman,	*Cincinnati, O.*	464 Chapel st.
Cadmus Zaccheus Gordon,	*Brookville, Pa.*	44 York sq. pl.
Henry Sturges Guthrie,	*Buffalo, N. Y.*	50 Trumbull st.
William Jerome Haldeman,	*Cincinnati, O.*	464 Chapel st.
John Elisha Morpeth Hall,	*Brooklyn, N. Y.*	46 York sq. pl.
William Torrence Handy,	*Cincinnati, O.*	221 Elm st.
Atreus Joshua Hargadine,	*St. Louis, Mo.*	7 Library st.
John Philip Henriques,	*New London,*	44 York sq. pl.
Samuel Ferris Hurd Hewit,	*Bridgeport,*	533 Chapel st.
William Stanley Hine,	*Bridgeport,*	Bridgeport.
Walter Holcomb,	*New Hartford,*	29 Prospect st.
William Coe Holmes,	*Waterbury,*	153 Crown st.
Horace Cobb Howard,	*Townsend, Vt.*	105 Park st.
Joseph Paxson Iddings,	*Orange, N. J.*	76 Howe st.

Charles Maples Jarvis,	*Binghamton, N. Y.*	72 High st.
Clifford Pearse Johnston,	*Lake Forest, Ill.*	167 Temple st.
Frederick Sheldon Judd,	*New Britain,*	12 Trumbull st.
Lawrence Kneeland,	*Brooklyn, N. Y.*	151 Crown st.
George Brewster Laflin,*	*Chicago, Ill.*	114 High st.
Elijah Thien Foh Laisun,	*Shanghai, China,*	226 Church st.
Frank Cooper Lawrance,	*New York City,*	488 Chapel st.
Alton Winslow Leighton,	*New Haven,*	137 Henry st.
Charles James Luck,	*Rouse's Point, N. Y.*	34 York sq. pl.
Arthur Martin,	*Orange, N. J.*	76 Howe st.
Ferrier John Martin,	*Orange, N. J.*	76 Howe st.
Frank Peterson Mitchell,	*Cincinnati, O.*	109 Elm st.
Charles Knox Mixter,	*Rock Island, Ill.*	16 Ashmun st.
Charles Arthur Montjoy,	*Lambayeque, Peru,*	15 Home pl.
James Blair Murray,	*Norwich,*	35 High st.
Samuel Lewis Penfield,	*Catskill, N. Y.*	193 Temple st.
William Francis Pier,	*Scranton, Pa.*	223 Elm st.
Henry Brooks Plumb,	*Terryville,*	533 Chapel st.
Willard Nourse Pratt,	*Elmira, N. Y.*	26 Tremont House.
Francis Rawlinson Read,	*Hartford,*	759 Chapel st.
George Francis Reynolds,	*New Haven,*	129 York st.
James Tracey Richards,	*Stratford,*	69 W. D. H.
Theodore William Riley,	*Scranton, Pa.*	223 Elm st.
Lucius Waterman Robinson,	*Fair Haven,*	225 Ferry st.
Thomas Weaver Rogers,	*Brooklyn, N. Y.*	8 Lock st.
Thomas Fitch Rowland,	*Greenpoint, N. Y.*	92 Chapel st.
Everett Rushmore,	*Mamaroneck, N. Y.*	147 York st.
William Thompson Sedgwick,	*Farmington,*	4 Library st.
Charles Dwight Smith,	*Plantsville,*	29 Prospect st.
George Smith,	*New Haven,*	164 Elm st.
Walter Snowdon Smith,	*Cincinnati, O.*	464 Chapel st.
George Elias Squires,	*East Haddam,*	202 Grand st.
Frederic Taintor,	*Hampton,*	167 Temple st.
Henry Ling Taylor,	*New York City,*	462 Chapel st.
Arthur John Tenney,	*New Haven,*	126 Crown st.
William Gilman Thompson,	*New York City,*	120 College st.
John Abeel Weekes,	*New York City,*	84 Wall st.
George Kellogg Welch,	*Hartford,*	167 Temple st.
Horace Lemuel Wells,	*New Britain,*	12 Trumbull st.
William Russell White,	*Danbury,*	41 High st.
Albert Daniel Wilson,	*Newburgh, N. Y.*	81 Wall st.
George Leverett Wilson,	*West Killingly,*	85 Bradley st.
Edwin Young,	*Honesdale, Pa.*	84 Wall st.
William Hopkins Young,	*Poughkeepsie, N. Y.*	85 Wall st.
Lemuel Yung,	*Macao, China,*	58 Temple st.

FRESHMEN, 89.

* Deceased.

SPECIAL STUDENTS NOT CANDIDATES FOR A DEGREE.

uel Forbes Adam,	*Canaan,*	64 W. D. H.
:les Edwin Bogue,	*Crown Point, N. Y.*	41 College st.
mas Attwater Bostwick,	*New Haven,*	162 Olive st.
sell Henry Chittenden,	*New Haven,*	23 Humphrey st.
uel Fessenden Clark,	*Geneva, Ill.*	58 N. S. H.
klin Wilson,	*Kilingworth,*	14 Park st.
ton Hart Merriam,	*Locust Grove, N. Y.*	42 Whitney av.
iam H. Osborne,	*Georgetown,*	85 Bradley st.
ert John Russell, Worcester Free Institute,	*Worcester, Mass.*	133 Dwight st.
iam Oakley Wallace,	*Ansonia,*	525 Chapel st.
ry Ellsworth Wood, CH.	*Joliet, Ill.*	8 Trumbull st.

SPECIAL STUDENTS, 11.

SUMMARY.

GRADUATES,	31
SENIORS,	56
JUNIORS,	62
FRESHMEN,	89
SPECIAL STUDENTS,	11
TOTAL,	249

SHEFFIELD SCIENTIFIC SCHOOL.

I.

Objects.

THE SHEFFIELD SCIENTIFIC SCHOOL is devoted to instruction and researches in the mathematical, physical, and natural sciences, with reference to the promotion and diffusion of science, and also to the preparation of young men for such pursuits as require especial proficiency in these departments of learning. It is one of the Departments of Yale College, like the law, medical, theological, and art schools, having its separate funds, buildings, teachers, and regulations, but governed by the Corporation of Yale College, which appoints the professors and confers the degrees. It is, in part, analogous to the academic department or classical college, and, in part, to the professional schools.

The instruction is intended for two classes of students:—

I. Graduates of this or of other Colleges, and other persons qualified for advanced or special scientific study.

II. Undergraduates who desire a training chiefly mathematical and scientific, in less part linguistic and literary, for higher scientific studies, or for various other occupations to which such training is suited.

II.

History and Organization.

The School was commenced in 1847. In 1860, a convenient building and a considerable endowment were given by Joseph E. Sheffield, Esq., of New Haven, whose name, at the repeated request of the Corporation of Yale College, was afterward attached to the foundation. Mr. Sheffield has since frequently and munificently increased his original gifts.

In 1864, by an act of the Connecticut Legislature, the national grant for the promotion of scientific education (under the congressional enactment of July, 1862) was given to this department of Yale College, which thus became "the College of Agriculture and the Mechanic Arts for Connecticut." Since that time, and

especially since the autumn of 1869, numerous liberal gifts have been received from the citizens of New Haven, and from other gentlemen in Connecticut, New York, and St Louis, for the endowment of the School, and the increase of its collections.

The action of the State led to the designation by law of a State Board of Visitors, consisting of the Governor, Lieutenant-Governor, three senior Senators, and the Secretary of the State Board of Education; and this Board, with the Secretary of the Scientific School, is also the Board for the appointment of students to hold the State scholarships.

At the request of the Governing Board, the Corporation of Yale College has also appointed a Board of Councillors for the School, consisting of a number of gentlemen who have taken a deep interest in its welfare.

The Governing Board consists of the President of Yale College and the Professors who are permanently attached to the School. There are several other instructors associated with them, a part of whom are connected with other departments of the College.

III.

Building and Apparatus.

The two buildings in which the work of instruction in the Scientific School is carried on are called Sheffield Hall and North Sheffield Hall. These contain a large number of recitation and lecture rooms, a hall for public assemblies and lectures, chemical and metallurgical laboratories, a photographical room, an astronomical observatory, museums, a library and reading room, besides studies for some of the professors, where their private technical libraries are kept.

The following is a summary statement of the collections belonging to the School:—

1. Laboratories and Apparatus in Chemistry, Metallurgy, Physics, Photography, and Zoölogy.
2. Metallurgical Museum of Ores, Furnace Products, etc.
3. Agricultural Museum of Soils, Fertilizers, useful and injurious insects, etc.
4. Collections in Zoölogy.
5. Astronomical Observatory, with an equatorial telescope by Clark and Sons of Cambridge, a meridian circle, etc.
6. A collection of Mechanical Apparatus, constituting the "Collier Cabinet."
7. Models in Architecture, Geometrical Drawing, Civil Engineering, Topographical Engineering, and Mechanics; diagrams adapted to public lectures; instruments for field practice.

8. Maps and Charts, topographical, hydrographical, geological, etc.

The mineralogical cabinet of Professor Brush, the herbarium of Professor Brewer, the collection of native birds of Professor Whitney, and the astronomical instruments of Professor Lyman, are deposited in the building. Professor Eaton's herbarium, near at hand, is freely accessible.

Students are also admitted, under varying conditions, to the College and Society libraries, the College Reading Room, the Cabinet of Minerals and Fossils, the School of the Fine Arts, and the Gymnasium.

IV.

The Library.

The special technical library of the Scientific School consists of about five thousand volumes. Included in this is the "Hillhouse Mathematical Library" of twenty-four hundred volumes, collected during a long series of years by Dr. William Hillhouse, and five years ago purchased and presented to the Institution by Mr. Sheffield. A Catalogue of this collection forms a supplement to the Annual Report of the Governing Board for 1870.

The following scientific journals are received regularly at the Library, and are accessible to all for consultation.

AMERICAN.

Journal of the Franklin Institute.
Engineering and Mining Journal.
Scientific American.
Mining and Scientific Press.
Van Nostrand's Eclectic Engineering Magazine.
Railroad Gazette.
Bulletin of the National Association of Wool Manufacturers.
American Chemist.
American Journal of Science.

ENGLISH.

Agricultural Gazette, The.
Annals and Magazine of Natural History.
Builder, The.
Economist, The.
Engineer, The.
Engineering.
Farmer's Magazine.
Garden, The.
Gardiner's Chronicle, The.
Grevillea.
Iron.
Journal of the Anthropological Institute.
——— of the Chemical Society.

Journal, Quarterly, of Microscopical Science.
——— Quarterly, of Pure and Applied Mathematics.
——— Quarterly, of Science.
Magazine, The Botanical.
Mining Journal, The.
Monthly Notices of the Royal Astronomical Society.
Nature.
News, The Chemical, and Journal of Physical Science.
Philosophical Magazine, The London, Edinburgh, and Dublin.

FRENCH.

Annales de Chimie et de Physique.
——— Nouvelles de la Construction.
——— des Ponts et des Chaussées.
Archives de Zoölogie Experimentale et Generale.
Bulletin de la Société de Géographie.
——— de Société Chimique.
Connaisance des Temps.
Journal d'Agriculture Pratique.
——— de Zoologie.
Mémoires de la Société d'Anthropologie de Paris.
Mondes, Les.
Revue Scientifique.
——— Universelle des Mines.
Technologiste, Le.

GERMAN.

Annalen der Landwirthschaft.
——— der Physik und Chemie.
Archiv für Anthropologie.
Berichte der Deutschen Chemischen Gesellschaft.
Centralblatt Chemisches.
——— Polytechnisches.
Civil-Ingenieur, Der.
Hedwigia.
Jahrbuch, Berliner Astronomisches.
——— über die gesammten Fortschritte der Mathematik.
Journal für praktische Chemie.
——— für reine und angewandte Mathematik.
Landwirthschaftliche Jahrbücher.
Milch-Zeitung.
Nachrichten, Astronomische.
Polytechnisches Journal, Dingler's.
Repertorium für Experimental-Physik, etc.
Zeitschrift für Biologie.
——— für Analytische Chemie.
——— für Math. und Naturw. Unterricht.
——— für Wissenschaftliche Zoologie.
Zeitung, Berg-und Hüttenmännische.
——— Botanische.

Niederländisches Archiv für Zoologie.

Numerous scientific journals, not included in this list, can be found in the private libraries of various professors, which are deposited in the building, and are accessible for consultation; and in the College library there are a much larger number of others, especially of the proceedings of foreign academies and scientific societies.

V.

Instruction for Graduate and Special Students.

Persons who have gone through undergraduate courses of study, here or elsewhere, may avail themselves of the facilities of the School for more special professional training in the physical sciences and their applications, gaining in one, two, or three years the degree of BACHELOR OF PHILOSOPHY, or, in two additional years of Engineering study, that of CIVIL ENGINEER, or of DYNAMICAL ENGINEER.

Or, engaging in studies of a less exclusively technical character, they may become candidates for the degree of DOCTOR OF PHILOSOPHY. The instruction in such cases will be adapted to the particular needs and capacities of each student, and may be combined with that given by the graduate instructors in other departments of the University. This degree is conferred upon those who, having already taken a Bachelor's degree, engage as students in the Department of Philosophy and the Arts for not less than two years in assiduous and successful study. It is not given upon examination to those whose studies are pursued elsewhere. The requirements for it will in some cases exact of the student more than two years of post-graduate labor; so, especially, wherever the course of undergraduate study has been, as in the Scientific School, of less than four years. The candidate must pass a satisfactory final examination, and present a thesis giving evidence of high attainment in the branches of knowledge to which he has attended. A good knowledge of Latin, German and French will be required in all cases, unless, for some exceptional reason, the candidate be excused by the Faculty. The graduating fee is ten dollars.

Subjects likely to receive special attention are suggested as follows:—

Professor NORTON will instruct in applied mechanics and in spherical astronomy.

Professor LYMAN, in the use of meridional and other astronomical instruments, and in astronomical spectroscopy.

Professor TROWBRIDGE, in the principles of thermodynamics, and utilization of heat as a source of power.

Professor BRUSH, in the analysis and determination of mineral species, and in descriptive mineralogy.

Professor JOHNSON, in theoretical, analytical, and agricultural chemistry.

Professor BREWER, in agriculture and forest culture, in the use of the microscope, and in physical geography.

Professor CLARK, in definite integrals, differential equations, analytical mechanics, the theory of numerical approximations, and the method of least squares.

Professor EATON, in structural and systematic botany, including the North American flora and the description of genera and species.

Professor MARSH, in palæontology and comparative osteology.

Professor WALKER, in public finance and in the statistics of industry.

Professor ALLEN, in analytical chemistry, and in metallurgy.

Professor VERRILL, and Mr. S. I. SMITH, in zoölogy and geology.

The same courses of study are open, for a longer or shorter time, to graduate students who do not desire to become candidates for a degree.

Students who have taken the degree of Bachelor of Philosophy, may obtain the degree of CIVIL or of DYNAMIC ENGINEER at the end of two academical years, by pursuing the following higher course of study and professional training.

The course of study for the degree of CIVIL ENGINEER will comprise

1. Higher Calculus. Higher Geometry. Theory of Numerical Operations.
2. Analytical Mechanics. Mechanics applied to Engineering.
3. A Course of Construction and Design. Projects.
4. Practical Astronomy, with use of instruments, computations, etc.

This course will occupy three academical terms.

To secure the requisite amount of professional knowledge and practice, the candidate will be required to furnish a comprehensive report of the results of an examination into the existing condition of some special line of constructive art; or to present proper evidence that he has had actual charge in the field, for several months, of construction or surveying parties, or held some responsible position deemed equivalent to this.

An elaborate design must also be submitted of some projected work of construction, based upon exact data obtained from careful surveys made by the candidate, and comprising all the requisite calculations, and the necessary detailed drawings, and accompanied by full specifications of the work to be done, and the requirements to be met by the contractor.

The fee for this degree is five dollars.

The course of study for the degree of DYNAMICAL ENGINEER will comprise

1. Higher Calculus, General Theory of Equations and of Numerical Operations.
2. General Principles of Dynamics (Analytical Mechanics). Including special application of these principles to Dynamical problems.
3. Construction of Machines. Designs.
4. Preparation of theses on special subjects in Dynamic Engineering.

During the second year candidates will be permitted to employ such a portion of their time as may be deemed advisable or necessary in the examination of engineering works and manufacturing establishments, and may also have the privilege of entering upon professional practice, provided it is done with the knowledge and consent of the Professor of Dynamic Engineering, and under such circumstances as shall appear to him to be favorable to professional progress.

An elaborate thesis on some professional subject, with an original design, or project, accompanied by proper working drawings, will be required at the end of the second year.

The fee for this degree is five dollars.

SPECIAL STUDENTS.—For the benefit of those who, being fully qualified, desire to pursue particular studies without reference to the obtaining of a degree, special or irregular students are received in most of the departments of the School; not, however, in the Select Course or in the Freshman Class.

It should be distinctly understood that these opportunities are not offered to persons who are incompetent to go on with regular courses, but are designed to aid those who, having received a sufficient preliminary education elsewhere, desire to increase their proficiency in special branches.

VI.

Requirements for Admission.

TERMS OF ADMISSION.—Candidates must be not less than sixteen years of age, and must bring satisfactory testimonials of moral character from their former instructors or other responsible persons.

For admission to the Freshman Class the student must pass a thorough examination in the following subjects:

English Grammar—including spelling and composition.
History of the United States.
Geography.
Latin—Six books of Cæsar's commentaries or their equivalent, and simple exercises in prose composition.

Arithmetic—including the Metric System.
Algebra—Davies' Bourdon, or Loomis's Treatise, as far as the general theory of equations; or an equivalent.
Geometry—the nine books of Davies' Legendre, or the ten books of Loomis' Elements; or an equivalent.
Plane Trigonometry—the solution of Plane Triangles and the Trigonometrical Formulæ contained in Davies' Legendre, or Loomis's Trigonometry.
(In Geometry, in the examinations of 1876, Chauvenet's Geometry, or an equivalent, will be required. In the examinations of 1877, Snowball and Lund's Course of Elementary Natural Philosophy* will be required.)

The examinations for admission take place at North Sheffield Hall, on Friday and Saturday, July 2, 3; and on Tuesday and Wednesday, September 14, 15, 1875. Opportunity for private examination may, in exceptional cases, be given at other times.

Candidates for advanced standing in the undergraduate classes are examined, in addition to the preparatory studies, in those already pursued by the class they propose to enter. No one can be admitted as a candidate for a degree later than at the beginning of the Senior year.

For the guidance of students purposing to enter this institution, the following information is furnished in regard to the requirements in certain studies; not necessarily because the subjects mentioned are of any more importance in themselves, but because experience has shown that they are the subjects in which candidates are generally apt to be to a greater or less extent deficient.

* Published by Macmillan & Co., London and New York.

Arithmetic.—The examination in this study will embrace the leading topics taught in the high schools of the country. It will extend to the rationale of arithmetical processes as well as to the processes themselves; and candidates should, therefore, have carefully reviewed the subject, after having attained sufficient maturity to comprehend it.

Algebra.—The following subjects will receive special attention in the examination in this branch:

The fundamental operations upon both entire and fractional expressions, including factoring; the solution of equations of the first and second degrees; the reduction of inequalities; the theory of fractional and negative exponents, and the calculus of radicals; the application of the binomial formula, whatever be the exponent; the method of indeterminate co-efficients; and the theory and use of logarithms. There is far too often a general want of thoroughness in the preparation of candidates in this fundamental branch of mathematical analysis.

Geometry.—In this subject the candidate should have in his preparation a sufficient number of not too difficult exercises in geometrical invention, such as can be chosen from the works of Loomis, Chauvenet, Tappan, and Olney, and further found in abundance in various English and other foreign collections. Particular attention should also be paid to exercises in the elementary formulæ of mensuration.

Trigonometry.—In Trigonometry it is absolutely requisite that the candidate make himself thoroughly familiar with the deduction of the formulæ, with the use of the trigonometrical tables, and the solution of plane triangles. He should besides be exercised as far as practicable in simple trigonometrical transformations. Todhunter's "Trigonometry for Beginners" will furnish abundant material for this class of exercises. In his trigonometrical calculations, as in all others, he should study the art of neat and orderly arrangement, as an important means to a valuable end. If the use of logarithms is postponed till trigonometry is taken up (which is by no means advisable), it should embrace all forms of calculation occurring in ordinary practice, as well as those appearing in the solution of triangles; since any one of the former is liable at any time to appear in the work given in the examinations.

Latin.—In order to assure the attainment of the desired proficiency in this study, the student should have such continued

training in parsing as shall make him thoroughly familiar with declension and conjugation, and accurate and ready in the application of the rules of syntax. It will also contribute greatly to the mastery of these grammatical elements, if the practice of translating from English into Latin, both orally and in writing, be methodically pursued. The deficiencies frequently manifested at examination could seldom exist, if this double system of parsing and of translation into Latin were more generally followed. A knowledge of prosody will not be required.

VII.

Instruction for Undergraduate Students.

COURSES OF INSTRUCTION, occupying three years, are arranged to suit the requirements of various classes of students. The first year's work is the same for all; during the last two years the instruction is chiefly arranged in special courses.

The special courses most distinctly marked out are the following:—

(a.) In Chemistry;
(b.) In Civil Engineering;
(c.) In Dynamic (or Mechanical) Engineering;
(d.) In Agriculture;
(e.) In Natural History;
(f.) In studies preparatory to Medical Studies;
(g.) In studies preparatory to Mining and Metallurgy;
(h.) In Select studies preparatory to other higher studies.

The arrangement of the studies is indicated in the annexed scheme.

FRESHMAN YEAR.—INTRODUCTORY TO ALL THE COURSES.

FIRST TERM.—*German*,—Whitney's Grammar and Reader. *English*,—Hadley's Brief History of the English Language; Exercises in Composition. *Mathematics*,—Plane Analytical Geometry. *Physics*,—Atkinson's Ganot, with experimental lectures. *Chemistry*,—Eliot and Storer's Manual: Laboratory practice. *Elementary Drawing*,—Practical Lessons in the Art School.

SECOND TERM.—*Language, Physics, Chemistry, and Drawing*,—As stated above. *Mathematics*,—Elements of the Theory of Numerical Approximations; Solution of Higher Numerical Equations; Methods of Interpolation. *Physical Geography*,—Lectures.

THIRD TERM.—*German and Physics*,—As stated above. *Mathematics*,—Analytical Geometry in Space; Spherical Trigonometry. *Botany*,—Gray's Lessons. *Polit. Economy*,—Elementary Lectures. *Drawing*,—Orthographic Projection.

For the Junior and Senior years the students select for themselves one of the following courses:—

(a.) IN CHEMISTRY.

JUNIOR YEAR.

FIRST TERM.—*Theoretical and Organic Chemistry*,—Lectures. *Qualitative Analysis*,—Fresenius. *Laboratory Practice. Blowpipe Analysis. German. French.*

SECOND TERM.—*Laboratory Practice*,—Qualitative Analysis, continued. Quantitative Analysis, begun. *Mineralogy*,—Blowpipe Analysis and Determination of Species. *Zoology*,—Lectures. *German. French.*

THIRD TERM.—*Laboratory Practice*,—Quantitative Analysis, continued. *Mineralogy*,—Lectures. *Zoology*,—Lectures and Excursions. *German. French.*

SENIOR YEAR.

FIRST TERM.—*Laboratory Practice*,—Volumetric and Organic Analysis. *Geology*.—Dana's. *Zoology*,—Lectures. Excursions. *French.*

SECOND TERM.—*Laboratory Practice*,—Mineral Analysis and Assaying. *Agricultural Chemistry*,—Recitations and Lectures (optional). *Geology*,—Dana's. *Metallurgy* (optional). *French. Zoology*,—Lectures.

THIRD TERM.—*Laboratory Practice.* Preparation of Thesis. *Agricultural Chemistry*,—Lectures (optional). *Geology*,—Dana's. *Metallurgy* (optional). *Mineralogy* (optional). *French. Zoology*,—Lectures.

(b.) IN CIVIL ENGINEERING.

JUNIOR YEAR.

FIRST TERM.—*Mathematics*,—Differential and Integral Calculus. Descriptive Geometry. *Surveying*,—Field Operations. *Drawing*,—Binns' Orthographic Projections. *German. French.*

SECOND TERM.—*Mathematics*,—Integral Calculus. Rational Mechanics. *Drawing*,—Projection of Shadows and Perspective. *German. French.*

THIRD TERM.—*Mathematics.* Rational Mechanics. Descriptive Geometry. Warped Surfaces. *Surveying*,—Topographical. *Drawing*,—Topographical. *German. French.*

SENIOR YEAR.

FIRST TERM.—*Field Engineering*,—Laying out Curves. Location of line of Railroad, with calculations of Excavation and Embankment. Hencks' Field Book for Railroad Engineers. *Civil Engineering*,—Mahan's. *Stone Cutting*,—with graphical problems. *Geology*,—Dana's. *Mineralogy*,—Blowpipe Analysis and Determinative Mineralogy. *Drawing*,—Architectural and Structural. *French.*

SECOND TERM.—*Civil Engineering*,—Resistance of Materials. Bridges and Roofs. Building Materials. *Astronomy*,—Loomis's Astronomy, with practical problems. *Mineralogy*,—continued. *Geology*,—Dynamic. *French.*

THIRD TERM.—*Civil Engineering*,—Bridges and Roofs. Stability of Arches and Walls. *Dynamics*,—Principles of Mechanism. Steam Engine. *Hydraulics*,—Hydraulics and Hydraulic Motors.

(c.) IN DYNAMICAL ENGINEERING.

JUNIOR YEAR.

FIRST TERM.—*Mathematics.* Differential and Integral Calculus. Descriptive Geometry. *Instrumental Drawing. German. French.*

SECOND TERM.—*Mathematics.* Integral Calculus. Rational Mechanics. *Instrumental Drawing. German. French.*

THIRD TERM.—*Mathematics.* Rational Mechanics. *Drawing.* Binns' Second Course, including drawing of gearing, perspective, shades and shadows, tinting, construction of warped surfaces, and isometric drawing. *German. French.*

SENIOR YEAR.

FIRST TERM.—*Drawing,*—Construction of Machines from actual measurements in the shops. *General Theory of Motion,*—Applications of this theory to the motions of bodies, and to the motions of parts of machines. *General Theory of Gearing,*—Cams, connections by bands, links, cords, and hydraulic connections. General principles of trains of mechanism. Mechanical powers. Aggregate combinations in mechanism (Rankine). *Theory of Valve Motions* (Zeuner). *Applied Mechanics,*—Machinery and mill work. Dynamics of Machinery (Rankine), commenced. *French. Geology.*

SECOND TERM.—*Applied Mechanics,*—continued. *Dynamics of Machinery,*—Theory of Machines.—Special applications of the Theory of Machines to problems involving the efficiency of machines and to special machines. *Materials used in construction,* their composition and qualities, iron, steel, alloys, wood, animal substances. Drawing (construction of machines), continued. *Theory of Elasticity,*—Principles of construction of roof-trusses, beams, girders, and bridges. Principles relating to resistance to torsion of shafts, to shearing, and to stiffness and stability of structures. (Rankine.) *Heat,*—General principles. Application of principle of specific heat. Action of bodies under the influence of heat. Change of states of aggregation. Expansion. Applications of law of Mariotte and Gay Lussac. Gases. Vapors. Laws of expansion. Densities. Elastic force of gases and vapors. Quantities of heat. Latent heats of fusion and evaporation. *Combustion,*—Quantities of air required, nature of products, heat evolved. *Fuel,*—Kinds and quantities, Transfer of heat. *Description of Steam Generators,*—Principles of construction of steam generators. *Geology. French.*

THIRD TERM.—*Prime Movers in General,*—Animal mechanics, water powers, heat engines, regulators, dynamometers, valves, brakes, fly-wheels, governors, measurement of friction, &c. *Water Power Engines,*—Sources of water power, measurement of supply. Construction of conduits. Measurements of flow. Hydraulic press. Water pressure engines. *Water Wheels,*—Overshot, undershot and breast wheels. Reaction wheels. Turbine wheels. Wind power. *Heat Engines.*—Principles of thermodynamics. Air engines. Steam engines. Efficiency of steam and air engines. Mechanism of steam and air engines. Drawing of structures. *Metallurgy.*

(d.) IN AGRICULTURE.

JUNIOR YEAR.

FIRST TERM.—*Theoretical and Organic Chemistry.*—Lectures. *Experimental and Analytical Chemistry,*—in their Agricultural applications. Laboratory Practice. *Physical Geography. Mineralogy,*—Blowpipe Analysis and Determinative Mineralogy. *English. German. French.*

SECOND TERM.—*Agricultural Chemistry,*—Recitations. *Experimental Chemistry,*—Laboratory Practice. *Physical Geography. Mineralogy.* Lectures. *English. German. French.*

THIRD TERM.—*Agricultural Chemistry,*—Lectures. *Horticulture and Kitchen Gardening.*—Lectures. *Experimental Chemistry,*—Laboratory Practice. *Botany and Zoology,*—with Excursions. *Mineralogy,*—continued. *English. German. French.*

SENIOR YEAR.

FIRST TERM.—*Agriculture,*—Cultivation of the Staple Crops of the Northern States. *Agricultural Zoology,*—Origin and Natural History of Domestic Animals. Insects useful and injurious to Vegetation. *Geology,*—Dana's. *English. French. Excursions,*—Agricultural, Botanical, etc.

SECOND TERM.—*Agriculture,*—Stock raising and principles of Breeding. *Geology,*—Dana's. *Human Anatomy and Physiology,*—Lectures. *English. French.*

THIRD TERM. - *Rural Economy,*—History of Agriculture and Sketches of Husbandry in Foreign Countries. Systems of Husbandry. *Geology,*—Dana's. *English.*

(e.) IN NATURAL HISTORY.

(Either Geology, Mineralogy, Zoology, or Botany may be made the principal study, some attention in each case being directed to the other three branches of Natural History.)

JUNIOR YEAR.

FIRST TERM.—*Chemistry,*—Qualitative Analysis. Laboratory Practice. Recitations. *Mineralogy,*—Blowpipe Analysis and Determinative Mineralogy. *Botany,*—Gray's Text-Book; Use of the Microscope. *German. French.*

SECOND TERM.—*Zoology,*—Laboratory Practice. *Physiology,*—Huxley's. *Botany,*—Laboratory Practice; Gray's Text-Book. *Mineralogy,*—Lectures. *Physical Geography. German. French.*

THIRD TERM.—*Zoology,*—Laboratory Practice. Lectures, Excursions (land and marine). *Anatomy of Vertebrates,*—Huxley's. *Botany,*—Practical Exercises, Excursions. *Mineralogy,*—continued. *German. French.*

SENIOR YEAR.

FIRST TERM.—*Geology,* Dana's. Excursions. *Zoology,*—Laboratory Practice. Lectures. Excursions. *Botany,*—Herbarium Studies. Excursions. *Linguistics,*—Whitney's Language and the Study of Language. *French.*

SECOND TERM.—*Geology,*—Dana's. *Zoology*—Laboratory Practice. Excursions. *Botany,*—Herbarium Studies. Botanical Literature. Essays in Descrip-

tive Botany. *Linguistics*,—Whitney's Language and the Study of Language. *French.*

THIRD TERM.—*Geology, Zoology, and Botany*—continued, with Excursions. *Meteorology. French.*

Besides the regular courses of recitation and lectures on structural and systematic Zoology and Botany, and on special subjects, students are taught to prepare, arrange, and identify collections, to make dissections, to pursue original investigations, and to describe Genera and Species in the language of science. For these purposes, large collections in Zoology and Palæontology belonging to the College are available, as are also the private botanical collections of Professor Eaton.

(f.) IN PREPARATION FOR MEDICAL STUDIES.

During the Junior year, the work of this course will be chiefly under the direction of the instructors in Chemistry. Especial attention will be given to qualitative and quantitative analysis, in their physiological and medical bearings; and to the preparation and study of the organic proximate elements. In the Senior year, the work will be chiefly under the direction of the Professors of Zoology and Botany. Attention will be paid in Zoology to comparative anatomy, embryology, the laws of hereditary descent, and human parasites; and in Botany to a general knowledge of structural and physiological Botany, and to medicinal, food-producing, and poisonous plants. The order of studies is as follows:

JUNIOR YEAR.

FIRST TERM.—*Chemistry*,—Qualitative Analysis, Fresenius'. Laboratory Practice. Recitations. *Mineralogy*,—Blowpipe Analysis and Determinative Mineralogy. *German. French.*

SECOND TERM.—*Physiological Chemistry*,—Klein's Handbook. Laboratory Practice. Recitations. *Physiology*,—Huxley's. *Mineralogy*,—continued. *German. French.*

THIRD TERM.—*Physiological Chemistry*,—Klein's. Laboratory Practice. Recitations. *Zoology*,—Lectures and Excursions. *Botany*,—Lectures, Practical Exercises and Excursions. *Mineralogy*,—continued. *German. French.*

SENIOR YEAR.

FIRST TERM.—*Comparative Anatomy and Physiology*,—Laboratory Practice. *Anatomy of Vertebrates*.—Huxley's. *Botany*,—Practical Exercises, Lectures, and Excursions. *Geology*,—Dana's. *Zoology*,—Lectures and Excursions. *French.*

SECOND TERM.—*Comparative Anatomy and Systematic Zoology*,—Lectures. Laboratory Practice. *Botany*,—Lectures. Laboratory Practice. *Geology*,—Dana's, *French.*

THIRD TERM.—*Comparative Anatomy and Physiology*,—Laboratory Practice. *Zoology, Botany and Geology*—continued, with Excursions.

(g.) IN STUDIES PREPARATORY TO MINING AND METALLURGY.

Young men desiring to become Mining Engineers, can pursue the regular course in Civil or Mechanical Engineering, and at its close can spend a fourth year in the study of metallurgical chemistry, mineralogy, etc.

(h.) IN THE SELECT STUDIES PREPARATORY TO OTHER HIGHER STUDIES.

JUNIOR YEAR.

FIRST TERM.—*Mineralogy*,—Blowpipe Analysis and Determinative Mineralogy. *Astronomy. Physical Geography. English*,—Langland's Vision of Piers Plowman, and Chaucer. *History*,—Freeman's Outlines. *French. German.*

SECOND TERM.—*Mineralogy*,—Lectures. *Astronomy. Physical Geography. English*,—Chaucer, Shakespeare. *History*,—Freeman's Outlines, with Lectures. *German. French.*

THIRD TERM.—*Botany and Zoology*,—Lectures and Excursions and Laboratory Practice. *English*,—Shakespeare. *Political Economy*,—Walker's Science of Wealth. *German. French.*

SENIOR YEAR.

FIRST TERM.—*Geology*,—Recitations and Excursions. *Botany*,—Lectures, Excursions and Laboratory Practice. *Zoology*,—Lectures and Excursions. *Linguistics*,—Whitney's Language and the Study of Language. *English*,—Shakespeare. *History*,—Constitutional History of the United States. Lectures. *Political Economy*,—Lectures. *French.*

SECOND TERM.—*Geology and Zoology*,—continued. *Linguistics*,—Whitney's Language and the Study of Language. *Political Economy*,—Lectures. *English*,—Shakespeare and Milton. *History*,—Political History of the United States. Lectures. *French.*

THIRD TERM.—*Geology*,—Recitations and Excursions. *Zoology*,—Lectures. *Meteorology. English*,—Dryden and Pope. *History*,—Lectures. History of Europe since 1848. *Political Economy*,—Lectures.

Exercises in English Composition are required during the entire course from all the students. The preparation of graduating theses is among the duties of the Senior year.

Lectures on Military Science and Tactics are annually given.

Drawing.

The course in drawing extends through the three years. During the first term and half of the second term of Freshman year, the students practice free-hand drawing at the Art School building, under the direction of Professor Niemeyer, of the Yale School of the Fine Arts. After the completion of the course in free-hand drawing, instruction is given by Mr. F. R. Honey, during the second half of the year, in the elementary principles of instrumental drawing, embracing the whole of Binns' first course of orthographic projections. This course is obligatory upon all.

During the Junior and Senior years, instruction in drawing is obligatory only on the students in Civil and Mechanical Engin-

eering. In the former year the system of instruction embraces Binns' second course in orthographic projections, isometric drawing, shades and shadows, tinting, perspective, and warped surfaces. By this method all the problems in Descriptive Geometry are required to be worked out on the drawing-board instead of the black-board. The course extends through the entire year, and is under the direction of Mr. Honey.

In Senior year, students are required to apply the principles of drawing already obtained to works of construction, under the general supervision of the Professors of Civil and of Dynamic Engineering.

VIII.

Methods of Instruction.

The instructions of this institution are given chiefly in small class rooms, recitations or familiar lectures, illustrated by the apparatus at the command of the various teachers. In many studies weekly excursions are made for the purpose of collecting specimens and examining natural phenomena.

In Chemistry and Metallurgy the students work several hours daily in well appointed laboratories, under the direct superintendence of the instructors, and are guided through systematic courses of quantitative and qualitative analysis, assaying, and the blow-pipe determination of minerals and ores.

In Botany, during the summer of Junior year, exercises in analyzing and identifying plants occur two or three times a week, followed by practice in writing characters and descriptions of plants from living specimens. Students are shown also the best methods of collecting and preserving for future study, specimens of Flowering Plants, Ferns, Mosses, Algæ, &c. In the autumn term of Senior year the work of the summer is continued. Students are encouraged to pursue special lines of Botanical investigation, and varied assistance is rendered them according to their needs. The final examination is intended to show what they have learned, and the collections they have made are considered to be of minor importance.

In Zoology weekly excursions are made during the third term of Junior and first term of Senior year, in company with the instructors, for the purpose of observing the habits and making collections of marine, fresh-water, and terrestrial animals of all classes. Each student is required to prepare and present for

examination a collection containing a specified number of species, and illustrating the various classes of animals. He must also be able to pass an examination upon his collection, at least to the extent of explaining the classes and orders illustrated, and showing why particular specimens belong to the respective classes.

In Geology excursions are made for the purpose of examining geological phenomena and making special collections of rocks and minerals. Each student is required to pass a satisfactory examination on his collections at the end of the first term of Senior year.

In addition to the above, a course of lectures is given every winter by the professors of the school and others, on topics of popular interest.

IX.

Tuition Charges.

The charge for tuition is $150 per year, payable, $55 at the beginning of the first and of the second term, and $40 at the beginning of the third term. The special student of Chemistry has an additional charge of $70 per annum for chemicals and use of apparatus. He also supplies himself at his own expense with gas, flasks, crucibles, etc., the cost of which should not exceed $10 per term. A fee of $5 is charged members of the Freshman Class for chemicals and materials used in their laboratory practice, and the same fee is required from all who take the practical exercises in Blow-pipe Analysis and Determinative Mineralogy. An additional charge of $5 is annually made to each student for the use of the College Reading Room and Gymnasium.

X.

Church Sittings.

Free sittings for students in this department of Yale College are provided as follows:

In the Center Church (Cong.): Pews Nos. 36 and 42, in the North Gallery.

In Trinity Church (Episc.): Pews Nos. 175 and 177, in the North Gallery.

In the First Methodist Church: Pew No. 78, at the head of the West Aisle (below).

Any of the students may occupy a sitting in these slips. Those who prefer to pay for a sitting for a year, more or less, in the

churches above mentioned, or in any other church of any denomination, will be aided on application to the Secretary of School.

Sittings in the Gallery of the College Chapel are free as heretofore to the students of this department.

XI.

Degrees.

Students of this department, on the recommendation of the Governing Board, are admitted by the Corporation of Yale College to the following degrees. They are thus conferred:

1. BACHELOR OF PHILOSOPHY: on those who complete any of the three-year courses of study, passing all the examinations in a satisfactory manner, and presenting a graduation thesis.

The fee for graduation as Bachelor of Philosophy, including the fee for Triennial Catalogues, Commencement Dinners, etc., is ten dollars; unless the person taking the degree is also an academical graduate, when it is but five dollars.

2. CIVIL ENGINEER and DYNAMICAL ENGINEER: The requirements for these degrees are stated on pages 19 and 20.

3. DOCTOR OF PHILOSOPHY: The requirements for this degree are stated on page 18.

XII.

Terms and Vacations.

The next academic year begins Thursday, September 10, 1875. The vacations correspond with those of the Academical Department, giving three weeks at Christmas, two weeks in the Spring, and eleven weeks in the Summer.

XIII.

Announcement in Respect to State Students.

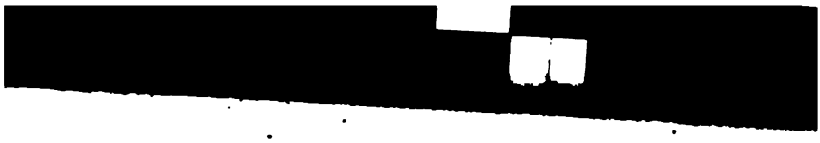
The scholarships established in this School in consequence of the bestowal upon it of the Congressional grants are designed to aid young men who are in need of pecuniary assistance in fitting themselves for agricultural and mechanical pursuits of life. All applicants must be citizens of Connecticut. In case there are more applicants than vacancies, candidates will be preferred who have lost a parent in the military or naval service of the United States, and next to these such as are most in need of pecuniary

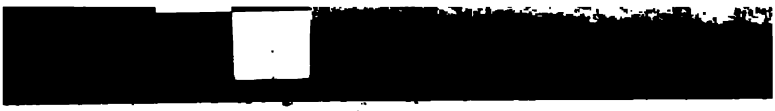
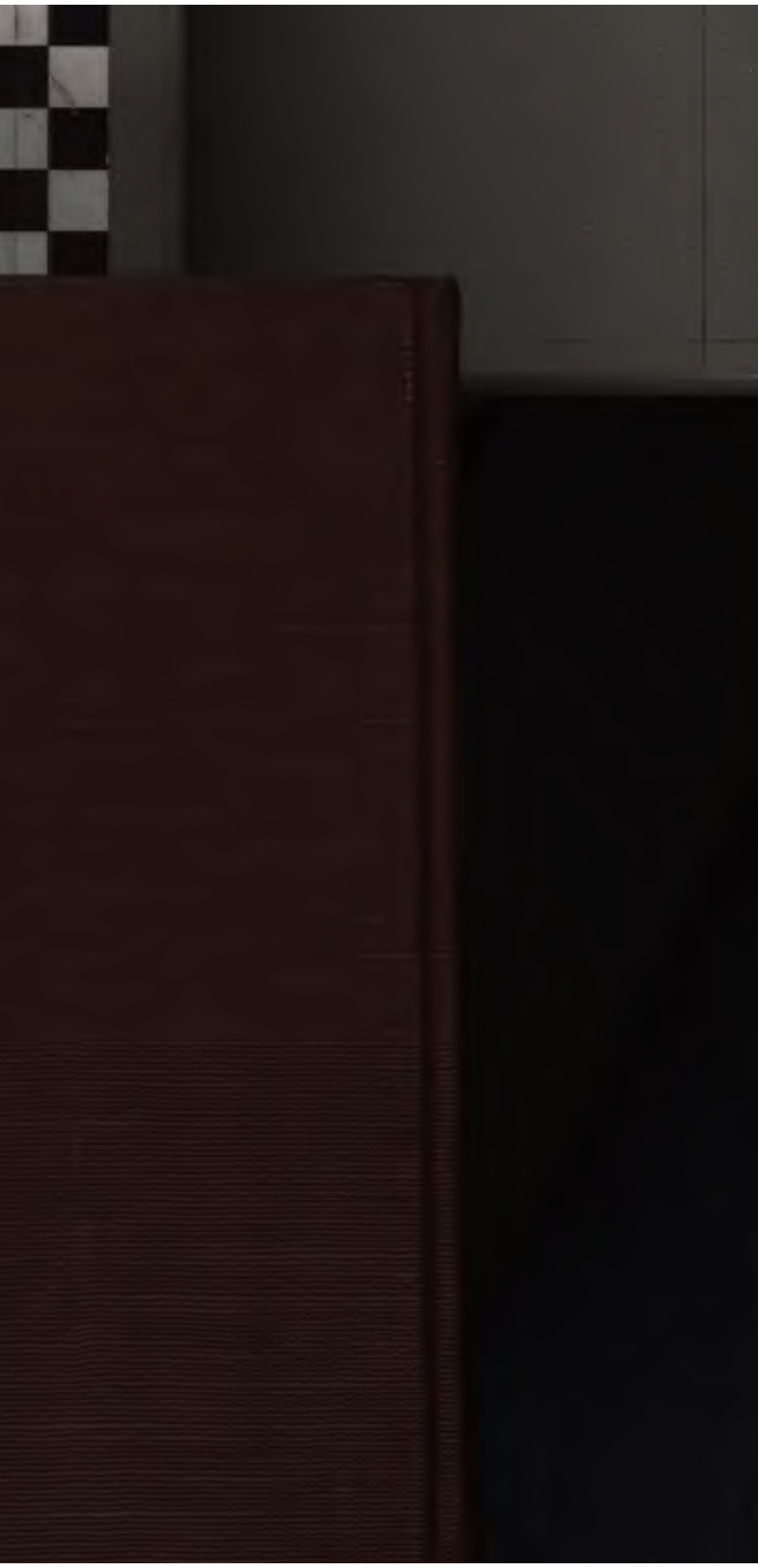
assistance: and the appointments will be distributed as far as practicable among the several counties in proportion to their population. The Appointing Board for the current year, consisting of the Board of Visitors of the State and the Secretary of the School, will meet on June 29, 1875, and at about the same time in the year 1876, due notice of which will be given by publication in every county of the State. All applications should be made previous to that time. Blank forms for application will be sent, when requested, by Professor GEORGE J. BRUSH, Secretary of the Appointing Board.

XIV.

Anniversary.

The Anniversary of the School is held on Tuesday of the Commencement week in Yale College, June 29, 1875, when selections from the graduation theses are publicly read. The degrees are publicly conferred by the President and Fellows of Yale College on Commencement-Day.

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